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THE AUTOMOBILE AS USED IN THE FRENCH MILITARY MANEUVERS—GENERAL DE NEGRIER OF THE ARMY OF THE NORTH.

THE AUTOMOBILE IN MODERN WARFARE.

The very rapid progress made in automobilism within the last year or two, says L'Illustration, has so far increased the efficiency of the automobile as a safe and sure means of rapid transportation that the French army-officers, in the recent maneuvers, determined to ascertain to what extent motor-carriages could be used in war. The vehicles used can be divided into three classes: 1, automobiles for the transportation of the personnel; 2, automobiles for the transportation of special *matériel;* 3, traction-engines for the transportation of heavy guns and stores.

The vehicles of the first class are more or less similar to those in general use. De Dion-Bouton tricycles were employed by the staff-officers for the rapid transmission of orders and dispatches. The machines were painted the regulation gray, the color which has been adopted for the artillery for the reason that of all hues it is least visible at great distances. Written commands were carried in a bag suspended from the handle-bar. More than twenty tricycles of the De Dion-Bouton type were employed by the several staffs under the command of General Brugère.

A Decauville voiturette with a carrying capacity of three has been especially designed for the rapid transportation of staff-officers. Several voiturettes of this type were also employed during the maneuvers.

Three years ago Panhard & Levassor, the well-known automobile manufacturers, were commissioned to build an eight-seat omnibus of 12 horse power capable of traveling at a speed of 22 miles an hour. Each of the two armies at this year's maneuvers was furnished with one of these vehicles.

A high-speed automobile for staff use was built in 1896 by the Société d'Electricité et d'Automobiles Mors. This machine was used on several occasions, notably during the maneuvers of 1898. The vehicle has a speed of 36 miles an hour and a carrying capacity of four. In the last maneuvers five automobiles of this pattern were employed.

For the commanding general of an army or of an army corps, Peugeot has specially designed a very comfortable carriage of 12 horse power and a speed of 18 miles an hour. The two front seats are occupied by the driver and an orderly. In the center the general and the chief of his staff are seated; a closet, a desk, two lamps, are furnished for their convenience. In the rear, room for two staff-officers is provided, as well as a small table, a lamp, and hooks for the swords. An opening enables the officers to communicate with the compartment of the commanding general. The baggage is placed on the top of the vehicle.

The second class, as we have already remarked, includes automobiles designed for the transportation of special *matériel.* In this class we find a surgeon's carriage of improved form. The forward part is reserved for the driver and two invalids. The partition which serves as a support for the wounded men is movable, so that it can be pushed aside to expose a compartment containing an operating-table provided with the usual surgical appliances. The center of the carriage is sectioned off into twelve compartments provided with sliding doors opening on the side of the vehicle. The twelve compartments contain baskets for medicines, bandages and the like. Beneath the vehicle two large boxes are carried for larger objects, surgical instruments, etc. In the rear is a small compartment with sufficient room for two surgeons, a table, lamp, hooks, etc. The seat-boxes each inclose a water reservoir of six gallons. Near the door of the rear compartment is a small closet which contains a sterilizer supplying pure water. On the other side of the door a ladder is suspended, by which the top of the vehicle, where canteens, stretchers, etc., are kept, can be reached. Above the sterilizer a tent is folded, which, when unrolled and secured by one edge to the carriage, serves as a hospital. This vehicle is driven by its 10 horse power motor at speeds varying from 3 to 12 miles an hour. Solid rubber tires are employed, for the reason that pneumatic tires are too easily punctured and that great speeds are not necessary.

Georges Richard has built an army postal automobile with a speed of eighteen miles an hour. The vehicle resembles previous models of this type.

One of the most interesting of the many appliances tested at the maneuvers was the Renault voiturette search-light. The voiturette itself was an ordinary automobile driven by a three horse power motor. In the rear of the carriage a dynamo, furnishing a current of 30 amperes at a pressure of 40 volts, was mounted. The armature was directly driven by the motor through the medium of a universal joint. The dynamo generates current for a search-light of the usual pattern, mounted upon an aluminium tripod. With the intense light thrown by this apparatus, a newspaper can be read at a distance of two miles from the source of light. The telegraph supply wagon is exactly similar to that ordinarily employed in the army. The maximum speed is eighteen miles an hour.

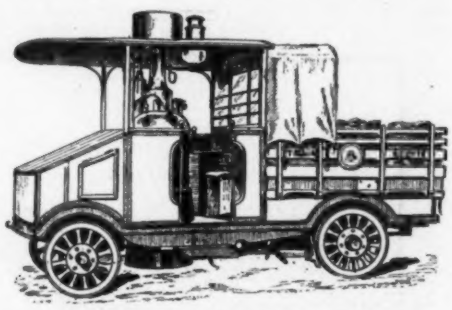
The automobile telegraph office is one of the most ingenious contrivances used by the army. Behind the front seat is a removable partition. When the carriage is stopped to communicate with the other end of the line, the partition is raised; the telegraph operators turn around, face the instrument table, and transmit their messages when their instruments have been connected with the line by two men who are especially carried along for the purpose.

The third class is composed primarily of traction-engines for the transportation of heavy artillery, regimental trains, bridge trains, field bakeries, etc. The traction-engines are of the well-known Scotte and De Dion-Bouton types. The Scotte engine is the most powerful machine of its kind. It recently climbed a ten per cent. grade hauling siege guns weighing 55,000 pounds. Both the Scotte and De Dion engines are driven by steam. The rear portion of the Scotte engine is reserved for the storage of coal and is provided with two seats for the attendants. The rear compartment of the De Dion-Bouton vehicle can be employed for the transportation of goods. The fuel capacity is less than that of the Scotte engine; nevertheless, the vehicle can easily cover 42 miles with a single charge of coke.

Of all the automobiles employed by the French army, these traction-engines gave the most promise of future success. Despite their cost, they are less expensive than the horses for which they are substituted. The repairs which must inevitably be made by no means equal the loss of draft animals during a war. The coal or coke consumed as fuel can be obtained for one-quarter the cost of fodder, and occupies but one-twentieth of the space. In actual warfare it is a matter of no little difficulty to procure fodder; coal, on the other hand, is found almost everywhere. The train of an army corps is reduced from 14 to 6 miles in length if traction-engines alone are employed. The normal speed of a draft-animal is 2½ to 4 miles, the maximum speed, 4 to 5 miles an hour; a day's journey rarely exceeds 16 miles. With traction-engines, on the contrary, the normal speed attainable is 4¼ to 5 miles; in an emergency, 7½ to 11 miles can be covered in an hour. Since a machine never becomes tired, no limit can be set on the distances which can be traversed.

MAIL WAGON.


TELEGRAPH SUPPLY WAGON.


SCOTTE TRACTION ENGINE.


SURGEON'S WAGON AND AMBULANCE.


AUTOMOBILE TELEGRAPH WAGON.


CARRIAGE OF THE COMMANDING GENERAL.

[Continued from Supplement, No. 1292, page 20712.]

INAUGURAL ADDRESS.

By Prof. Sir William Turner, President of the British Association for the Advancement of Science, Bradford Meeting.

DEVELOPMENT OF THE EGG.

As the future of the entire organism lies in the fertilized egg cell, we may now briefly review the arrangements, consequent on the process of segmentation, which lead to the formation, let us say in the egg of a bird, of the embryo of the young chick.

In the latter part of the last century, C. F. Wolff observed that the beginning of the embryo was associated with the formation of layers, and in 1817 Pander demonstrated that in the hen's egg at first one layer, called mucous, appeared, then a second or serous layer, to be followed by a third, intermediate or vascular layer. In 1828 Von Baer amplified our knowledge in his famous treatise, which from its grasp of the subject created a new epoch in the science of embryology. It was not, however, until the discovery by Schwann of cells as constant factors in the structure of animals and in their relation to development that the true nature of these layers was determined. We now know that each layer consists of cells, and that all the tissues and organs of the body are derived from them. Numerous observers have devoted themselves for many years to the study of each layer, with the view of determining the part which it takes in the formation of the constituent parts of the body, more especially in the higher animals, and the important conclusion has been arrived at that each kind of tissue invariably arises from one of these layers and from no other.

The layer of cells which contributes, both as regards the number and variety of the tissues derived from it, most largely to the formation of the body is the middle layer or mesoblast. From it the skeleton, the muscles, and other locomotor organs, the true skin, the vascular system, including the blood and other structures which I need not detail, take their rise. From the inner layer of cells or hypoblast, the principal derivatives are the epithelial lining of the alimentary canal and of the glands which open into it, and the epithelial lining of the air passages. The outer or epiblast layer of cells gives origin to the epidermis or scarf skin and to the nervous system. It is interesting to note that from the same layer of the embryo arise parts so different in importance as the cuticle—a mere protecting structure, which is constantly being shed when the skin is subjected to the friction of a towel or the clothes—and the nervous system, including the brain, the most highly differentiated system in the animal body. How completely the cells from which they are derived had diverged from each other in the course of their differentiation in structure and properties is shown by the fact that the cells of the epidermis are continually engaged in reproducing new cells to replace those which are shed, while the cells of the nervous system have apparently lost the power of reproducing their kind.

In the early stage of the development of the egg, the cells in a given layer resemble each other in form, and, as far as can be judged from their appearance, are alike in structure and properties. As the development proceeds, the cells begin to show differences in character, and in the course of time the tissues which arise in each layer differentiate from each other and can be readily recognized by the observer. To use the language of Von Baer, a generalized structure has become specialized, and each of the special tissues produced exhibits its own structure and properties. These changes are coincident with a rapid multiplication of the cells by cleavage, and thus increase in size of the embryo accompanies specialization of structure. As the process continues, the embryo gradually assumes the shape characteristic of the species to which its parents belonged, until at length it is fit to be born and to assume a separate existence.

The conversion of cells, at first uniform in character, into tissues of a diverse kind is due to forces inherent in the cells in each layer. The cell plasm plays an active though not an exclusive part in the specialization; for as the nucleus influences nutrition and secretion, it acts as a factor in the differentiation of the tissues. When tissues so diverse in character as muscular fiber, cartilage, fibrous tissues, and bone arise from the cells of the middle or mesoblast layer, it is obvious that, in addition to the morphological differentiation affecting form and structure, a chemical differentiation affecting composition also occurs, as the result of which a physiological differentiation takes place. The tissues and organs become fitted to transform the energy derived from the food into muscular energy, nerve energy, and other forms of vital activity. Correspond-

ing differentiations also modify the cells of the outer and inner layers. Hence the study of the development of the generalized cell layers in the young embryo enables us to realize how all the complex constituent parts of the body in the higher animals and in man are evolved by the process of differentiation from a simple nucleated cell—the fertilized ovum. A knowledge of the cell and of its life history is therefore the foundation stone on which biological science in all its departments is based.

If we are to understand by an organ in the biological sense a complex body capable of carrying on a natural process, a nucleated cell is an organ in its simplest form. In a unicellular animal or plant such an organ exists in its most primitive stage. The higher plants and animals again are built up of multitudes of these organs, each of which, while having its independent life, is associated with the others, so that the whole may act in unison for a common purpose. As in one of your great factories each spindle is engaged in twisting and winding its own thread, it is at the same time intimately associated with the hundreds of other spindles in its immediate proximity in the manufacture of the yarn from which the web of cloth is ultimately to be woven.

It has taken more than fifty years of hard and continuous work to bring our knowledge of the structure and development of the tissues and organs of plants and animals up to the level of the present day. Amid the host of names of investigators, both at home and abroad, who have contributed to its progress it may

Of the younger generation of biologists, Francis Maitland Balfour, whose early death is deeply deplored as a loss to British science, was one of the most distinguished. His powers of observation and philosophic perception gave him a high place as an original inquirer, and the charm of his personality—for charm is not the exclusive possession of the fairer sex—endeared him to his friends.

GENERAL MORPHOLOGY.

Along with the study of the origin and structure of the tissues of organized bodies, much attention has been given during the century to the parts or organs in plants and animals, with the view of determining where and how they take their rise, the order of their formation, the changes which they pass through in the early stages of development, and their relative positions in the organism to which they belong. Investigations on these lines are spoken of as morphological and are to be distinguished from the study of their physiological or functional relations, though both are necessary for the full comprehension of the living organism.

The first to recognize that morphological relations might exist between the organs of a plant, dissimilar as regards their function, was the poet Goethe, whose observations, guided by his imaginative faculty, led him to declare that the calyx, corolla, and other parts of a flower, the scales of a bulb, etc., were metamorphosed leaves, a principle generally accepted by botanists, and indeed extended to other parts of a plant,

my personal knowledge of the condition of anatomical science in this country fifty years ago, that an enormous impulse was given to the study of comparative morphology by his writings and by the criticisms to which they were subjected.

There can be no doubt that generalized arrangements do exist in the early embryo which, up to a certain stage, are common to animals that in their adult condition present diverse characters and out of which the forms special to different groups are evolved. As an illustration of this principle, I may refer to the stages of development of the great arteries in the bodies of vertebrate animals. Originally, as the observations of Rathke have taught us, the main arteries are represented by pairs of symmetrically arranged vascular arches, some of which enlarge and constitute the permanent arteries in the adult, while others disappear. The increase in size of some of these arches, and the atrophy of others, are so constant for different groups that they constitute anatomical features as distinctive as the modifications in the skeleton itself. Thus in mammals the fourth vascular arch on the left side persists, and forms the arch of the aorta; in birds the corresponding part of the aorta is an enlargement of the fourth right arch, and in reptiles both arches persist to form the great artery. That this original symmetry exists also in man we know from the fact that now and again his body, instead of corresponding with the mammalian type, has an aortic arch like that which is natural to the bird, and in rarer cases even to the reptile. A type form common to the vertebrata

AUTOMOBILE USED BY GENERAL BRUGÈRE, COMMANDER IN CHIEF OF THE RECENT FRENCH MANEUVERS.

seem invidious to particularize individuals. There are, however, a few that I cannot forbear to mention, whose claim to be named on such an occasion as this will be generally conceded.

Botanists will, I think, acknowledge Wilhelm Hofmeister as a master in morphology and embryology, Julius von Sachs as the most important investigator in vegetable physiology during the last quarter of a century, and Strasburger as a leader in the study of the phenomena of nuclear division.

The researches of the veteran professor of anatomy in Würzburg, Albert von Kölliker, have covered the entire field of animal histology. His first paper, published fifty-nine years ago, was followed by a succession of memoirs and books on human and comparative histology and embryology, and culminated in his great treatise on the structure of the brain, published in 1896. Notwithstanding the weight of more than eighty years, he continues to prosecute histological research, and has published the results of his latest, though let us hope not his last, work during the present year.

Among our own countrymen, and belonging to the generation which has almost passed away, was William Bowman. His investigations between 1840 and 1850 on the mucous membranes, muscular fiber, and the structure of the kidney, together with his researches on the organs of sense, were characterized by a power of observation and of interpreting difficult and complicated appearances which has made his memoirs on these subjects landmarks in the history of histological inquiry.

which are referred to certain common morphological forms, although they exercise different functions. Goethe also applied the same principle in the study of the skeletons of vertebrate animals, and he formed the opinion that the spinal column and the skull were essentially alike in construction, and consisted of vertebræ, an idea which was also independently conceived and advocated by Oken.

The anatomist who in our country most strenuously applied himself to the morphological study of the skeleton was Richard Owen, whose knowledge of animal structure, based upon his own dissections, was unrivaled in range and variety. He elaborated the conception of an ideal, archetype vertebrate form which had no existence in nature, and to which, subject to modifications in various directions, he considered all vertebrate skeletons might be referred. Owen's observations were conducted to a large extent on the skeletons of adult animals, of the knowledge of which he was a master. As in the course of development modifications in shape and in the relative position of parts not unfrequently occur and their original character and place of origin become obscured, it is difficult, from the study only of adults, to arrive at a correct interpretation of their morphological significance. When the changes which take place in the skull during its development, as worked out by Reichert and Rathke, became known and their value had become appreciated, many of the conclusions arrived at by Owen were challenged and ceased to be accepted. It is however due to that eminent anatomist to state from

does therefore in such cases exist, capable of evolution in more than one direction.

The reputation of Thomas Henry Huxley as a philosophic comparative anatomist rests largely on his early perception of, and insistence on, the necessity of testing morphological conclusions by a reference to the development of parts and organs and by applying this principle in his own investigations. The principle is now so generally accepted by both botanists and anatomists that morphological definitions are regarded as depending essentially on the successive phases of the development of the parts under consideration.

The morphological characters exhibited by a plant or animal tend to be hereditarily transmitted from parents to offspring, and the species is perpetuated. In each species the evolution of an individual, through the developmental changes in the egg, follows the same lines in all the individuals of the same species, which possess therefore in common the features called specific characters. The transmission of these characters is due, according to the theory of Weismann, to certain properties possessed by the chromosome constituents of the segmentation nucleus in the fertilized ovum, named by him the germ plasm, which is continued from one generation to another, and impresses its specific character on the egg and on the plant or animal developed from it.

As has already been stated, the special tissues which build up the bodies of the more complex organisms are evolved out of cells which are at first simple in form and appearance. During the evolution of the in-

dividual, cells become modified or differentiated in structure and function, and so long as the differentiation follows certain prescribed lines the morphological characters of the species are preserved. We can readily conceive that, as the process of specialization is going on, modifications or variations in groups of cells and the tissues derived from them, notwithstanding the influence of heredity, may in an individual diverge so far from that which is characteristic of the species as to assume the arrangements found in another species, or even in another order. Anatomists had indeed long recognized that variations from the customary arrangement of parts occasionally appeared, and they described such deviations from the current descriptions as irregularities.

DARWINIAN THEORY.

The signification of the variations which arise in plants and animals had not been apprehended until a flood of light was thrown on the entire subject by the genius of Charles Darwin, who formulated the wide-reaching theory that variations could be transmitted by heredity to younger generations. In this manner he conceived new characters would arise, accumulate, and be perpetuated, which would in the course of time assume specific importance. New species might thus be evolved out of organisms originally distinct from them, and their specific characters would in turn be transmitted to their descendants. By a continuance of this process new species would multiply in many directions, until at length from one or more originally simple forms the earth would become peopled by the infinite varieties of plant and animal organisms which have in past ages inhabited, or do at present inhabit, our globe. The Darwinian theory may therefore be defined as Heredity modified and influenced by Variability. It assumes that there is an heredity quality in the egg, which, if we take the common fowl for an example, shall continue to produce similar fowls. Under conditions, of which we are ignorant, which occasion molecular changes in the cells and tissues of the developing egg, variations might arise in the first instance probably slight, but becoming intensified in successive generations, until at length the descendants would have lost the characters of the fowl and have become another species. No precise estimate has been arrived at, and indeed one does not see how it is possible to obtain it, of the length of years which might be required to convert a variation, capable of being transmitted, into a new and definite specific character.

The circumstance which, according to the Darwinian theory, determined the perpetuation by hereditary transmission of a variety and its assumption of a specific character depended, it was argued, on whether it possessed such properties as enabled the plant or animal in which it appeared to adapt itself more readily to its environment, i. e., to the surrounding conditions. If it were to be of use, the organism in so far became better adapted to hold its own in the struggle for existence with its fellows and with the forces of nature operating on it. Through the accumulation of useful characters, the specific variety was perpetuated by natural selection, so long as the conditions were favorable for existence, and it survived as being the best fitted to live. In the study of the transmission of variations which may arise in the course of development, it should not be too exclusively thought that only those variations are likely to be preserved which can be of service during the life of the individual, or in the perpetuation of the species, and possibly available for the evolution of new species. It should also be kept in mind that morphological characters can be transmitted by hereditary descent, which, though doubtless of service in some bygone ancestor, are in the new conditions of life of the species of no physiological value. Our knowledge of the structural and functional modifications to be found in the human body, in connection with abnormalities and with tendencies or predisposition to diseases of various kinds, teaches us that characters which are of no use, and indeed detrimental to the individual, may be hereditarily transmitted from parents to offspring through a succession of generations.

Since the conception of the possibility of the evolution of new species from pre-existing forms took possession of the minds of naturalists, attempts have been made to trace out the lines on which it has proceeded. The first to give a systematic account of what he conceived to be the order of succession in the evolution of animals was Ernst Haeckel, of Jena, in a well-known treatise. Memoirs on special departments of the subject, too numerous to particularize, have subsequently appeared. The problem has been attacked along two different lines: the one by embryologists, of whom may be named Kowalewsky, Gegenbaur, Dohrn, Ray Lankester, Balfour, and Gaskell, who, with many others, have conducted careful and methodical inquiries into the stages of development of numerous forms belonging to the two great divisions of the animal kingdom. Invertebrates, as well as vertebrates, have been carefully compared with each other in the bearing of their development and structure on their affinities and descent, and the possible sequence in the evolution of the vertebrata from the invertebrata has been discussed. The other method pursued by palæontologists, of whom Huxley, Marsh, Cope, Osborne and Traquair are prominent authorities, has been the study of the extinct forms preserved in the rocks and the comparison of their structure with each other and with that of existing organisms. In the attempts to trace the line of descent the imagination has not unfrequently been called into play in constructing various conflicting hypotheses. Though from the nature of things the order of descent is, and without doubt will continue to be, ever a matter of speculation and not of demonstration, the study of the subject has been a valuable intellectual exercise and a powerful stimulant to research.

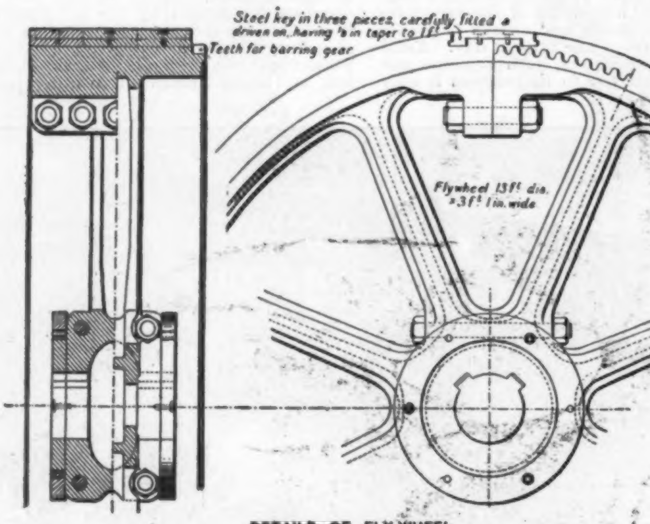
We know not, as regards time, when the fiat went forth, "Let there be Life, and there was Life." All we can say is that it must have been in the far-distant past, at a period so remote from the present that the mind fails to grasp the duration of the interval. Prior to its genesis our earth consisted of barren rock and desolate ocean. When matter became endowed with life, with the capacity of self-maintenance and of resisting external disintegrating forces, the face of nature began to undergo a momentous change. Living organisms multiplied, the land became covered with vegetation and multitudinous varieties of plants, from the humble fungus and moss to the stately palm and oak, beautified its surface and fitted it to sustain higher kinds of living beings. Animal forms appeared, in the first instance simple in structure, to be followed by others more complex, until the mammalian type was produced. The ocean also became peopled with plant and animal organisms, from the microscopic diatom to the huge leviathan. Plants and animals acted and reacted on each other, on the atmosphere which surrounded them and on the earth on which they dwelt, the surface of which became modified in character and aspect. At last man came into existence. His nerve-energy, in addition to regulating the processes in his economy which he possesses in common with animals, was endowed with higher powers. When translated into psychical activity, it has enabled him throughout the ages to progress from the condition of a rude savage to an advanced stage of civilization; to produce works in literature, art, and the moral sciences which have exerted, and must continue to exert, a lasting influence on the development of his higher Being; to make discoveries in physical science; to acquire a knowledge of the structure of the earth, of the ocean in its changing aspects, of the atmosphere and the stellar universe, of the chemical composition and physical properties of matter in its various forms, and to analyze, comprehend and subdue the forces of nature.

By the application of these discoveries to his own purposes man has, to a large extent, overcome time and space; he has studded the ocean with steamships, girdled the earth with electric wire, tunneled the lofty Alps, spanned the Forth with a bridge of steel, invented machines and founded industries of all kinds for the promotion of his material welfare, elaborated systems of government fitted for the management of great communities, formulated economic principles, obtained an insight into the laws of health, the causes of infective diseases, and the means of controlling and preventing them.

When we reflect that many of the most important discoveries in abstract science and in its applications have been made during the present century, and, indeed, since the British Association held its first meeting in the ancient capital of your county sixty-nine years ago, we may look forward with confidence to the future. Every advance in science provides a fresh platform from which a new start can be made. The human intellect is still in process of evolution. The power of application and of concentration of thought for the elucidation of scientific problems is by no means exhausted. In science is no hereditary aristocracy. The army of workers is recruited from all classes. The natural ambition of even the private in the ranks to maintain and increase the reputation of the branch of knowledge which he cultivates affords an ample guarantee that the march of science is ever onward, and justifies us in proclaiming for the next century, as in the one fast ebbing to a close, that great is Science, and it will prevail.

A LARGE GAS ENGINE.

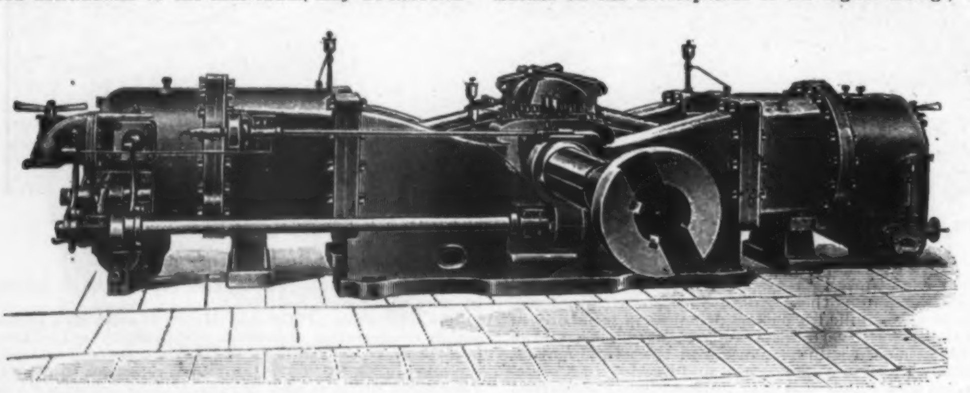
The largest gas engine yet turned out by Crossley Brothers, Limited, of Openshaw, Manchester, is illustrated below. As will be seen, says The Engineer, the engine is fitted with two horizontal cylinders, placed



DETAILS OF FLY-WHEEL

end to end on opposite sides of the crank shafts, both connecting rods being coupled to the same crank pin, one rod having a forked end. The dimensions of the cylinders are 26-inch by 36-inch stroke, and the normal speed of the engine is 150 revolutions per minute. The engine is attached direct to a dynamo by means of a flexible coupling, and is fitted with a very heavy fly-wheel, not shown in the engraving, 13 feet in diameter by 37 inches wide. It is made in halves, and is joined together by a new method. Unlike the usual means of connecting the sections of fly-wheels, this arrangement maintains the entire strength of the rim section through the joint, which is a matter of vital importance in the case of a fly-wheel having a high peripheral speed.

The engraving herewith shows this method of making joints for built-up fly-wheels. The engraving shows the fly-wheel built up in two halves, though the same method may be adopted for any number of sections. It consists of dove-tailed clips carefully machined to a definite taper, and driven on to corresponding machined joggles. The ends of the clips are also fitted to under-cut surfaces, which prevent them springing with the strain. As the clips can be made of a good quality steel, the amount of strain which may safely be put on them in tension can be accurately estimated, and they do not require to be very thick to enable them to be equal to a considerable section of the cast iron rim at the low tensile strain commonly estimated for in the rims of fly-wheels. The clips are not machined externally until fitted in place, and are then turned up with the fly-wheel itself, leaving a perfectly smooth uniform surface. These clips may be used both externally and internally, or as shown in the engraving externally only in combination with suitable bolts internally. One great advantage of this method of joining fly-wheels consists in having definite stresses upon the material which binds the parts of a fly-wheel together and coming on machined carefully fitted surfaces. The usual way of shrinking hoops on rough projecting bosses is not so satisfactory, owing to the difficulty of estimating the strain due to the shrinkage, the dependence on welds in the hoops, and the more or less imperfect fitting between the hoops and the rough surfaces.



THREE HUNDRED AND FIFTY HORSE POWER GAS ENGINE.

The engine was designed to work with Mond producer gas, and during a lengthy and severe test the results were most satisfactory, the output of the dynamo being 2,250 ampères at 110 volts, equal to 332 electrical horse power. Special attention has been given to the bearings and cooling arrangements, as the engine has to run day and night, without stopping, for long periods.

Each cylinder is fitted with a high-speed centrifugal governor which, by regulating the charge of gas and air, together with the great weight of the fly-wheel, maintains a practically steady turning moment. The charges of gas are both controlled by the governor, the volume of the charge remaining constant, and no working charge being cut out until the load on the engine falls below half the normal, beyond which it is not desirable to go for economic reasons.

The crank webs are fitted with heavy cast iron balance weights, and automatic sight-feed lubricators are fitted to all the bearings and parts requiring attention. In order to do away with the risk of broken breech ends, due to initial strains set up in the foundry, the ends of the cylinder water jackets are fitted with detachable covers, which also enable the water jackets to be easily cleared of any accumulation or deposit that so often causes trouble in gas engines.

The exhaust valves are fitted in detachable boxes in

stead of being cast on the cylinders. They are thus easily repaired or renewed should occasion arise. These valves are of a new design. Owing to the large diameter of the cylinders, and the correspondingly large diameter of the exhaust valves, considerable power would be required to open them if constructed on the ordinary lines. With a view to overcoming this difficulty an equilibrating arrangement has been adopted, which not only makes the opening of the large valves a very simple matter, but relieves the working parts of undue strain. The exhaust valves and spindles are hollow, and have water circulating through them, keeping them cool, and enabling an efficient lubrication to be maintained. This engine marks another advance in the direction of using gas for the production of large powers. So far La Société Cockerill has built the largest gas engine. But England is pressing Belgium closely.

NATURE OF ALLOYS.*

MOST students believed that certain definite chemical compounds existed in alloys. To prove this, however, certain means must be adopted to abstract the particular compounds. Ordinary chemical means of isolation were of no use under the circumstances. Fractional solution was effective in some cases, and by means of it several distinct metal compounds had been isolated from alloys, such as platinum-tin, copper-tin, zinc-copper, and other compounds. Another method was by observation of the "freezing point;" the molten mixture was cooled down slowly, and the temperature noted at which solid matter began to separate from the liquid. This varied with the proportion of the constituents, and by making many observations with varying proportions, a curve could be obtained of these solidifying temperatures, any irregularity pointing to the formation of something other than a mere mixture. By this means many interesting facts had been indicated which had subsequently been rendered evident by examination under the microscope. Valuable or interesting results had been thus obtained, both in this country and abroad, Prof. Roozeboom and Le Chatelier having particularly distinguished themselves in this direction. A remarkable instance of peculiarity was exhibited by mixtures of aluminium and antimony, when all the mixtures froze at a higher point than either of the components, and showed two irregularities indicative of two distinct compounds. In these mixtures it appeared that the component that predominated to a considerable extent acted as a solvent to the compound formed with the other component; but as the proportion of the other component was increased, the conditions became reversed. Interesting results had been obtained by observing, not only the freezing point, but also the point where the whole mass solidified, so that for every mixture the exact composition of the mass from which the compound had separated and of the separated compound was indicated. Roentgen-ray photography had also been utilized to demonstrate the formation of these intermetallic compounds. A long list of known and supposed alloy compounds was given in the report, and it appeared that the atomic relations generally held by chemists did not hold in the case of alloys.

THE FASTEST TRAINS OF THE WORLD IN 1899.

UNDER this title a correspondent writes to The Times (London) of August 17, and we reprint the article below. We suppose, from internal evidence, that the author of this article is Mr. W. M. Acworth, although we have no information of that fact. The detailed performance given in table No. 4 has been printed in The Railroad Gazette once, and probably twice, but it is worth printing again. Table No. 1 is not entirely correct for the year 1900. We believe that the Reading this year has but one train scheduled at 66·6 miles an hour, one minute having been added to the time of two others, slightly reducing the average speed. The Pennsylvania is running to Atlantic City one train at 65·5 miles an hour.

"Now that the summer holiday season has brought out our best trains and train services in Great Britain, it may be useful to set forth, for the edification of the student of such subjects and the general interest of the public, the fastest booked speeds of last year throughout the world, thus affording also a useful set of tables for comparative purposes. To any one who makes the attempt it will soon become evident that to collect and collate the information here given is a task of no small magnitude, and, in fact, no such thing has ever been done before. Table No. 1 shows that, of the nine fastest trains of the world, eight are run on the great competitive routes between Camden and Atlantic City, the Midi of France just managing to sandwich itself in the middle. This year the 'Atlantic City fliers' give us several more lightning runs; as the Philadelphia & Reading, yielding to suggestions made by the compiler of these tables, has put on two 'fliers' at 66·6 miles per hour in the opposite direction, and the moment these trains were announced, the Pennsylvania hurriedly put on corresponding ones at 64·3 miles per hour, and also quickened another train from Camden to Atlantic City to the same speed.

"The feature of this table is that only five English runs and three Scottish ones come up to the 55 miles per hour standard. This is bad enough, but when the tale of 1900 comes to be told, it will be seen that our French and American friends have gone still further ahead, while we have gone back. Needless to say, rigid punctuality is maintained on these lines. Would that one could say this for Great Britain.

"Table No. 2 compares the long French journeys with the running between the metropolitan cities of our two kingdoms by the shortest route.

"Table No. 3 disposes of the boast still printed in the official publications of the N. Y. C. & H. R. RR. that 'the Empire State Express is the fastest regular train on earth,' though she probably has the most difficulties to contend with in maintaining punctuality. The 'Sud Express,' however, has quickened again this year, and 'the great four-track road of America' must look to its laurels.

*Abstract of the Report of the Committee of the British Association. Read at the Bradford meeting by F. H. Neville, F.R.S.—Journal of the Society of Arts.

Table No. 1.

The Fastest Booked Speeds of the World in 1899 from Start to Stop.

Railroad.	From.	To	Miles.	Speed, start to stop. Miles per hour.
Phil. & Read. R. R.	Camden	Atlantic City	55½	66.6
" " "	"	" "	55½	66.6
Pennsylvania R. R.	"	" "	59	64.3
" "	"	" "	59	64.3
Midi	Morceux	Bordeaux (Controle)	67¾	61.6
Pennsylvania R. R.	Camden	Atlantic City	59	61.0
Phil. & Read. R. R.	"	" "	55½	60.5
" " "	Atlantic City	Camden	55½	60.5
" " "	" "	"	55½	60.5
Nord	Paris	Amiens	81¾	60.5
L. & S. W. R.	Dorchester	Wareham	15	60.1
" "	"	"	15	60.1
Pennsylvania R. R.	Camden	Atlantic City	59	60.0
" "	"	" "	59	60.0
Caledonian R.	Forfax	Perth	32½	59.1
Midi	Morceux	Dax	24½	58.2
"	"	Bordeaux (Controle)	67¾	58.1
Orleans	Orleans	Tours	69¾	58.1
"	Angoulême	Bordeaux	87½	57.6
"	Bordeaux	Angoulême	87½	57.6
Nord	Paris	St. Quentin	95¾	57.4
Orleans	Angoulême	Poitiers	70¼	57.0
Nord	Amiens	Calais Pier	104	57.2
N. Y. C. H. R. R.	Syracuse	Rochester	80	57.1
Pennsylvania R. R.	Atlantic City	Camden	59	57.0
" "	" "	"	59	57,0
" "	" "	"	59	57.0
Orleans	Poitiers	Angoulême	70¼	57.0
Phil. & Read. R. R.	Mass. Ave.	Camden	56.8	56.8
Caledonian R.	Stirling	Perth	33	56.5
Phil. & Read. R. R.	Atlantic City	Camden	55½	56.4
Nord	Longuean	Paris	79	56.4
Midi	Dax	Bayonne	31	56.3
"	Bayonne	Dax	31	56.3
Orleans	Angoulême	Poitiers	70¼	56.2
Midi	Morceux	Bordeaux	67¾	56.2
"	Bordeaux	Morceaux	67¾	56.2
Nord	Arras	Longuean	41¾	56.2
Orleans	Poitiers	Tours	62⅝	56.0
Nord	Paris	Longuean	79	55.8
N. Y. C. H. R. R.	Albany	Utica	95	55.8
Caledonian R.	Perth	Aberdeen	89¾	55.6
Nord	Paris	Busigny	113	55.6
"	"	Arras	120	55.5
Phil. & Read. R. R.	Camden	Atlantic City	55½	55.5
" " "	"	" "	55½	55.5
" " "	"	" "	55½	55.5
" " "	"	" "	55½	55.5
Orleans	Paris	Orleans	73¾	55.3
Pennsylvania R. R.	Camden	Atlantic City	59	55.3
" "	"	" "	59	55.3
G. N. R.	Peterborough	Finsbury Park	73¾	55.3
"	Hitchin	Huntingdon	26¾	55.3
N. E. R.	York	Darlington	44⅛	55.3
Orleans	Tours	Poitiers	62⅝	55.1
"	Orleans	Tours	69¾	55.1
Nord	Amiens	Boulogne	77	55.0

N. B.—It was found necessary to limit this return to 55 miles per hour, as the number of French and United States, and even British, runs at 53 and 54 is very great.—Extracted from Official Time Tables.
December, 1899.

Table No. 2.

French Expresses.—Complete Journeys, Including Stoppages. 1899.

Railroad.	From.	To.	Distance, miles.	No. of Stops.	Time Stoppages (Minutes).	Speed Inclusive of Stops, Miles Per Hour.
Midi	Bayonne	Bordeaux (Controle)	123	2	2	57.7
Nord	Paris	Calais Pier	185½	1	5	57.1
Midi	Bordeaux	Bayonne	123	2	2	55.8
"	Bayonne	Bordeaux	123	2	2	54.7
Orleans	Paris	"	363¼	4	17	54.2
Nord	"	Jeumont (Frontier)	148	1	5	53.8
Orleans	Bordeaux	Paris	363¼	4	17	53.0
"	Paris	Bordeaux (St. Jean)	363¼	4	17	52.4
Nord	"	Feignies (Frontier)	143½	1	4	51.9
"	Lille	Paris	155¼	3	8	51.7
Orleans	Bordeaux (Bastide)	"	359	4	17	51.4
Nord	Boulogne	"	158	1	5	51.3
Joint Service—Orleans and Midi (included in above list)	Paris	Bayonne	486¾	8	24	54.1

East Coast Expresses.

Train.	From.	To.	Miles.	Journey Rate, Including Stops, Miles Per Hour.
"Sleepers"	King's-cross	Edinburgh	393½	50.7
"Flying Scotsman"	"	"	393½	46.2
"Diner"	"	"	393½	46.7

"Table No. 4 will enable the public to realize that 66·6 miles per hour, start to stop, can be not only easily maintained, but improved upon. The official figures of 1899 were not available, though from trustworthy reports the running was quite as fine as in 1898. It must be borne in mind that these 'Atlantic City fliers' start on their swift career, and finish the same, through some miles of crowded streets, and that they are crossed at grade by the rival line, and the details of the daily running show that they are sometimes stopped by signals; and yet, thanks to powerful locomotives with ample boilers, the lost time is always made up, though it sometimes entails running at 88 miles an hour for 17 to 20 miles on end."—Railroad Gazette.

Table No. 3.

The Fastest Long Distance Trains of the World.
Showing booked speeds, 1899. Including all stops and slacks.

Route.	Railways.	From	To	Miles.	Time—Hours, minutes.	Stops.	Inclusive speed in miles per hour.
Sud Expr's	Orleans & Midi.	Paris...	Bayonne	486¾	8 59	6	54.13
Emp. State Express..	N. Y. C. & H. R. R. R.	N. York	Buffalo..	440	8 15	4	53.33*
East Coast.	Gt. N. and N. E. Railways.....	London.	Edinb'ro	393⅛	7 45	3	50.77
West Coast	L. & N. W. and Caledon'n Rys	London	Glasgow.	401⅛	8 00	3	50.18

*This train has no fewer than 28 booked slacks, many of them for miles through crowded streets, and in addition it is constantly checked at level crossings and drawbridges, and yet it is always on time at terminal.
December, 1899.

Table No. 4.

(From an Official Return to Theo. Voorhees, First Vice-President.)

"The Atlantic City Flyer." Philadelphia & Reading R. R. Speed (booked), 55½ miles in 50 minutes. Start to stop, 66.6 miles per hour. Locomotive No. 1028.

July, 1898.

Date.	Weight of Cars, Tons (British).	Minutes.	Miles per hour.
1	170	45¼	73.6
2	234	50¼	66.3
4	206	47	70.8
5	170	46½	71.6
6	170	49½	67.3
7	170	47¼	7.04
8	170	45¾	72.8
9	234	47	70.0
11	170	46	72.4
12	170	48	69.4
13	170	45¾	72.8
14	170	47¾	69.7
15	170	47	70.9
*16	234	52	64.0
		Stopped by signal.	
18	170	47	70.9
19	170	48½	68.7
20	170	49½	67.3
21	170	49	67.9
22	170	47	70.9
23	234	48½	68.7
25	170	47¾	69.7
26	170	47	70.9
27	170	47¼	70.5
28	170	47	70.9
29	170	48¾	68.3
30	234	48¼	69.0
		August, 1898.	
1	206	48¼	69.0
2	206	48¼	69.0
3	170	46¼	72.0
4	206	48¼	69.0
5	206	44¾	74.4
6	234	47¼	70.5
8	206	47	70.8
9	206	46	72.4
10	206	47	70.8
11	206	46	72.4
12	206	46	72.4
13	234	47¼	70.5
15	206	45¾	72.8
16	206	47¼	70.5
17	206	45½	73.2
18	206	46¾	71.2
19	206	45½	73.2
20	234	46¾	71.2
22	206	46¾	71.2
23	206	47¼	70.5
24	206	46¾	71.2
25	206	47	70.8
26	206	47¼	70.5
27	234	47¼	70.5
29	206	47	70.8
30	206	46	72.4
31	206	47	70.8

* "This signal was improperly thrown against the train either by accident or design."—Official Report.

The Platinum Gas Thermometer.—For work at high temperatures, the air thermometer with a platinum-iridium vessel is superior to a porcelain thermometer owing to the absence of softening, and the permeation of the gas, which in the case of hydrogen is troublesome, is obviated by substituting nitrogen for air or hydrogen. In continuation of their previous work on the subject, the authors have determined the correction to be applied on account of the expansion of the vessel. This expansion, which demands a correction of 10°, 30°, and 40° respectively at 500°, 1,000° and 1,150°, is not regular, and a further error of 1·5° to 7° is occasioned by the irregularity. The curve of expansion was determined by measuring the expansion of a rod made of the standard alloy, containing 80 per cent. of platinum and 20 per cent. of iridium. With a nitrogen thermometer subjected to the new corrections a number of melting points of metals were determined, so as to render future tests, especially those of thermo-elements, independent of the nitrogen thermometer. Thus the melting point of lead was found to be 326·9°; of pure silver, 961·5°; and of gold, 1,064·0°. The last value was verified by an optical method, the refractive index of air exposed to the temperature of the melting point being measured. This also gave 1,064°.—Holborn and Day, Ann. der Physik, No. 7, 1900.

The Marconi Wireless Telegraphy Company has arranged to supply the British Admiralty with Marconi apparatus for 32 ships and stations. The system has been subjected to very severe tests, and messages were transmitted a distance of 65 miles.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Nobel Prizes for Scientific Discoveries.—The Department of State has received a note from the legation of Sweden and Norway, dated Washington, September 11, 1900, inclosing copy (in French) of the laws and regulations relating to the Nobel bequest. The first award will take place December 10, 1901. A summary of the inclosure (printed by L'Imprimerie Royale, P. A. Norstedt & Söner, Stockholm, from whom copies can doubtless be obtained) follows:

LAWS AND REGULATIONS.

The three corporations awarding the Nobel prizes are:

1. The Royal Academy of Sciences, at Stockholm, founded in 1739. The King is the protector of the academy, which numbers 100 Swedish and Norwegian members and 75 foreign members.

2. The Swedish Academy, at Stockholm, instituted in 1786. The King is the protector. The members, exclusively Swedish, are limited to 18.

3. The Carolin Institute of Medicine and Surgery, at Stockholm, established in 1815. The number of professors is 22.

OBJECT OF THE ENDOWMENT.

The Nobel endowment is based on the will of Dr. Alfred Bernhard Nobel, engineer, drawn up November 27, 1895. The stipulations are as follows:

"The remainder of the fortune which I shall leave shall be disposed of in the following manner: The capital, converted into safe investments by the executors of my will, shall constitute a fund the interest of which shall be distributed annually as a reward to those who, in the course of the preceding year, shall have rendered the greatest services to humanity. The sum total shall be divided into five equal portions assigned as follows:

"1. To the person having made the most important discovery or invention in the department of physical science.

"2. To the person having made the most important discovery or having produced the greatest improvement in chemistry.

"3. To the author of the most important discovery in the department of physiology or of medicine.

"4. To the author having produced the most notable literary work in the sense of idealism.

"5. To the person having done the most, or the best, in the work of establishing the brotherhood of nations, for the suppression or the reduction of standing armies, as well as for the formation and the propagation of peace conferences.

"The prizes will be awarded as follows: For physical science and chemistry, by the Swedish Academy of Sciences; for works in physiology or medicine, by the Carolin Institute of Stockholm; for literature, by the Academy of Stockholm; finally, for the work of peace, by a committee of five members, elected by the Norwegian Stortung. It is my expressed will that nationality shall not be considered, so that the prize may accrue to the most-worthy, whether he be a Scandinavian or not."

The testamentary stipulations above cited serve as a basis for the regulations relating to the Nobel endowment, together with the explanations and the more detailed provisions contained in the present law, as well as in the deed of compromise, amicably brought about June 5, 1898, with certain of the heirs of the testator, and according to which the said heirs after an agreement concluded on the subject of a less important portion of the property left by Dr. Nobel, declared that they accepted the will of Dr. Nobel and renounced in all contingencies, for themselves and for their descendants, all claims for the remainder of the succession of the said Dr. Nobel and all share in the administration of the legacy; they abandoned, also, all right to protest against the interpretations or additions to the will or other limitations relative to its execution, and to the employment of the capital which might be now, or in the future, made by decision of the King or by competent authorities. The following reservations are, however, expressly stipulated:

a. That the common law for all the authorities charged with the distribution of the prizes, and governing the manner and the conditions of the distribution prescribed by the will, must be drawn up by common consent with a representative delegated by the family of Robert Nobel and submitted to the approval of the King.

b. That the following principles can not be deviated from, viz.:

1. That each of the annual prizes established by the will must be awarded at least once in the course of every period of five years, commencing with the year immediately following that in which the Nobel endowment shall enter on its functions, and that the sum total of a prize thus awarded shall in no case be less than 60 per cent. of the part of the yearly revenues disposable for the distribution of the prizes; neither can it be divided into more than three prizes at the most.

2. By the title "Academy of Stockholm" written in the will is understood the Swedish Academy.

By the word "literature" must be understood not only works purely literary, but also any other writing possessing by its form and its style a literary value. The limitation of the will declaring that the annual distribution of prizes must be directed to works executed "in the course of the preceding year" must be interpreted in this sense, that the objects of the rewards shall be the most recent results of research displayed in the departments indicated by the will; older works will be considered only in the event that their importance shall have been demonstrated in recent times.

3. In order to be admitted to the competition, every written work must have been published by means of the press.

4. The sum total of a prize may be divided equally between two works, if it be judged that each of them has merited the prize. If the work rewarded is the work of two or several assistants, the prize can be awarded to them in common. Any work the author of which is deceased cannot be the object of a prize; however, in case of death after the proposal for a reward has already been presented in the prescribed forms, the prize may be awarded. Each one of the corporations having the conferring of prizes has the right to decide whether the prize may be adjudged to an institution or to a society.

5. According to the plain intention of the will, a work cannot be rewarded unless experience or a competent examination shall prove its preponderant importance. If none of the works submitted to the competition possess the quality desired, the sum total of the prize is reserved for the following year. If, then, the prize cannot be distributed, the amount is deposited in the principal funds, unless three-fourths of the persons voting shall decide to establish with it a special fund for the section. The revenues of such a fund may, according to the decision of the corporation, be employed to encourage, otherwise than by the distribution of prizes, the tendencies aimed at in the first place by the donor. Each special fund will be administered with the principal fund.

6. For each section of Swedish prize, the competent corporation shall designate a "Nobel Committee," composed of three or five members, who shall give their advice upon the conferring of the prize. The necessary examination for the awarding of the peace prize shall be made by the committee of the Norwegian Stortung mentioned in the will. In order to be named a member of a Nobel committee, it is not necessary to be a Swedish subject nor to belong to the corporation charged with the conferring of the prize. The members of a Nobel committée can receive a suitable fee for their work, which will be determined by the competent corporation. In a special case, if it is judged necessary, the corporation can designate a competent person to take part as a member in the deliberations and in the decision of the Nobel committee.

7. For admission to the competition, it is necessary to be proposed in writing by a qualified person. No attention will be paid to requests addressed by persons desiring to obtain a prize themselves. It is explained further on who are considered qualified. The annual competition considers proposals which have been offered in the course of the year immediately preceding up to the date of February 1.

8. Every proposal must be accompanied by the writings and other documents upon which it is founded. If the proposal is not drawn up in either one of the Scandinavian languages or in English, French, German, or Latin, or if, for the appreciation of the proposed work, the body having to award the prize finds itself, for the most part, obliged to take cognizance of a writing composed in a language whose interpretation would cause special difficulties or considerable expense—in either of these cases, the corporation will not be obliged to proceed to a detailed examination of the proposal.

9. At the solemn reunion, which takes place on the anniversary of the death of the donor, December 10, the corporations will make known publicly their decisions and bestow upon each laureate a check for the value of the prize, a diploma, and a gold medal bearing the effigy of the donor with an appropriate legend. The laureate is obliged, unless prevented, to give during the six months following the reunion a public lecture on the subject of the work crowned. This lecture will be given in Stockholm, or for the peace prize, in Christiania.

10. Decisions in regard to the awarding of prizes are without appeal. It is forbidden to insert a difference of opinion in the procés verbal, or to reveal it in any other manner.

11. Corporations have the right to establish scientific institutions and other establishments, in order to secure assistance for the examination which must precede the distribution of the prizes, and to serve, from other points of view, the aim of the endowment. These institutes and establishments, which form part of the endowment, shall be called "Nobel institutes."

12. Every Nobel institute is placed under the direction of the body which founded it. They are independent as regards their exterior situation and their finances; consequently, their revenues can not be utilized by the corporations awarding the prizes, nor by any other institution to cover the expenses of their private budgets. Professors having a fixed salary in a Nobel institute can not hold a like position at the same time in any other institution, unless by special authorization of the King. Corporations may install Nobel institutes on a common site, giving them a uniform organization; they can attach foreigners, men and women, to the institute.

13. One-fourth of the revenues of the principal fund, which each section disposes of annually, is reserved. After the payment of the immediate expenses for the distribution of the prizes, the rest of the amount reserved is employed in defraying the expenses of the Nobel institute in each section. The balance, after paying the expenses of the year, is set aside for the future needs of the institute.

MANAGEMENT OF THE ENDOWMENT FUND.

The board of administration is composed of five Swedish members, one of whom—the president—is named by the King; the others are chosen by representatives of the corporations. The managing-director is chosen by the board from among its own members. Members and substitutes are elected for a term of two years, commencing May 1. The board of administration manages the endowment fund and all property common to the sections, pays the prizes and the expenses attendant on their distribution, the expenses of the Noble institutes, engages all employes, determines the amount of their appointments and of their pensions, is empowered to appoint proxies, to prosecute and to answer, to plead and to act in the name of the endowment. The corporations awarding the prizes appoint fifteen representatives for two civil years. The Academy of Sciences chooses six and designates four substitutes; the other corporations each appoint three, with two substitutes. The representatives, called together by the oldest representative of the Academy of Sciences, elect one of their number as president. Nine votes, at least, are necessary to make a decision. A corporation failing to send representatives does not prevent the others from acting. The management and accounts of the board are examined every civil year by five examiners; each corporation appoints one, the King naming the fifth, who acts as president. The report upon the management must be given to the president before the end of February. The examiners must present their report to the representatives of the corporations before April 1. This report, giving a résumé of the employment of the different funds, will be published in the newspapers. The failure of any corporation to appoint an examiner, or of an examiner to act, does not prevent the other members from proceeding with the examination. Examiners, and also the head of the Department of Public Instruction and Worship, have free access to all books, accounts, and documents of the endowment.

All the investments of the fund must be examined and verified at least once a year. The representatives of the corporations have the right to decide, after the report of the examiners, whether the board of administration or any one of its members shall be discharged, or any other action taken against them. The King determines the salary of the managing director. The tenth part of the yearly net income of the principal fund is added to the capital; the interest of the sum destined for the prizes is added to the same fund until the distribution in prizes or otherwise.

TRANSIENT PROVISIONS.

Immediately after the approval of the King of the statute of endowment, the corporations will designate the stipulated number of representatives, who will assemble at Stockholm and elect the members of the board of administration, who will have the management of the endowment fund at the beginning of the year 1901. The executors of the will will take appropriate measures to terminate the settlement of the succession. The first distribution of prizes for all sections will take place, if possible, in 1901. From the endowment resources will be deducted: First, a sum of 300,000 crowns ($80,400) for each section—that is, 1,500,000 crowns ($402,000) in all—which, with the interest commencing from the 1st of January, 1900, will be used to cover, in proportion, the expenses of the organization of the Nobel institutes in addition to the sum the board of administration shall judge necessary for the acquisition of a special site destined for the administration of the endowment and including a hall for its meetings.

SPECIAL RULE GOVERNING THE AWARDING OF THE NOBEL PRIZES BY THE ACADEMY OF SCIENCES, ETC.

The right of presenting proposals for prizes belongs to—

1. Native and foreign members of the Royal Academy of Sciences.

2. Members of the Nobel committees for natural philosophy and chemistry.

3. Professors who have received the Nobel prize of the Academy of Sciences.

4. Ordinary and extraordinary professors of natural sciences and chemistry in the universities of Upsal, Lund, Christiania, Copenhagen, and Helsingfórs, in the Carolin Institute of Medicine and Surgery, the Superior Technical, Royal School, as well as to the professors of the same sciences in the Stockholm High School.

5. Incumbents of corresponding chairs of at least six universities or high schools, which the Academy of Sciences will select, taking care to divide them suitably between the different countries and their universities.

6. Learned men, to whom the academy shall judge proper to send an invitation to this effect.

The invitations shall be sent every year in the month of September. Proposals for the prize must be made before February 1 of the following year. They are classified by the Nobel committee and submitted to the college of professors. The Nobel committee decides which of the works presented shall be submitted to a special examination. The college of professors will pronounce definitely on the distribution of the prize in the course of the month of October. The vote is taken in secret; if necessary, the question may be decided by drawing lots.

SPECIAL RULE GOVERNING THE AWARDING OF THE NOBEL PRIZE BY THE SWEDISH ACADEMY, ETC.

The right to present candidates for the Nobel prize belongs to the members of the Swedish Academy, the French Academy, and the Spanish Academy, which resemble the Swedish Academy in their organization and aim; to the members of the literary departments of other academies, as well as to the members of literary institutions and societies analogous to academies; to professors of æsthetics of literature and of history in the universities. This order must be published at least every five years.

American Goods in the Levant.—Consul Mahin, of Reichenberg, under date of August 13, 1900, writes:

The British consul at Smyrna recently made the following report to his government:

During the past decade, the preponderance of Manchester in the cotton imports of Smyrna has been substantially shaken. In T cloth, American competition, which supplies more durable goods, has supplanted the English manufactures. In shirtings the Americans have also acquired the greater part of the market. America is likewise supplying prints, the people of the Levant regarding with high favor such goods from that country.

Index to Advance Sheets of Consular Reports.

The Reports marked with an asterisk (*) will be published in the Scientific American Supplement. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

THE NEW PSYCHOLOGY—THE INTERNATIONAL PSYCHOLOGICAL CONGRESS OF 1900.

By HERBERT ERNEST CUSHMAN, Ph.D.

THE International Psychological Congress, that met in Paris in August, is the fourth great assembly of psychologists. The first, the result of the efforts of M. Richet and the different societies that had for a long time been formed to discuss hypnotic phenomena and telepathic hallucinations, was held in Paris in 1889. The Congress was happy in having M. Ribot as its presiding officer on both these occasions. It is, moreover, important to note that the first Congress took the name of the Congress of Physiological Psychology.

The second Congress met in London in 1892, under the name of the Congress of Experimental Psychology. The president, the late lamented Prof. Sidgwick, explained the term "Experimental" to mean a science founded on observation and experiment.

The third Psychological Congress was held in Munich in 1896 and was called by the simple title of the International Congress of Psychology, a name which the Congress last August retained.

In passing upon the Congress of the present year, it is interesting to note that the president, M. Ribot, like his predecessors, Prof. Sidgwick and Prof. Stumpf, discussed in his opening address the progress that psychology had made since the immediately preceding Congress. Indeed, there is an important significance in the changes in the names of the Congress. At first calling itself Physio-psychological in opposition to the old Hegelian idealism, it laid its claims to the beginnings of a science. Then it enlarged its boundaries and called itself "Experimental."

In 1896 the world was the psychologist's field. Anything that interested man interested him. Any change in the direction of psychology would, therefore, be in its devotion to some particular groups of subjects. Its boundaries enlarged to their fullest possibility, psychology must turn upon itself and direct its attention to certain subjects favorable for the moment. The storm center of psychology has most certainly changed during the past four years. The present Congress, as well as the periodic psychological literature, shows in which direction it is moving.

About one hundred and sixty papers or communications were announced in the published prospectus of the Congress. These were divided among twelve sessions, six general and six subordinate. The subjects of the general sessions were:

1. The history of psychology—three lectures.
2. Cerebral physiology—six lectures.
3. The phenomena of somnambulism—six lectures.
4. Philosophical problems connected with psychology—six lectures.
5. Experimental psychology—five lectures.
6. Social and pathological psychology—six lectures.

SUBORDINATE SESSIONS.

The subjects for the subordinate sessions were:

1. Social psychology and psychology in its agreement with anatomy and physiology—thirteen communications.
2. Introspective psychology in its agreement with philosophy—twenty-nine communications.
3. Pathological psychology and psychiatry—twenty-one communications.
4. Experimental and psycho-physical psychology—twenty-six communications.
5. Psychology of hypnotism and suggestion—twenty communications.
6. Social and criminal psychology—ten communications.

From the above list it will be seen that the Congress divided its time as follows: *

	Sessions.	Lectures.	Communications.
To history of psychology..	1	3	..
To physiology....	3	6	34
To psycho-physics..........	2	5	26
To pathology....	4	6	47
To social psychology.......	3	6	26
To philosophy............	2	6	29

This table shows the great amount of interest by psychologists at the present time in the physiological aspects of their problems. Of the fifteen* sessions, seven were given to physiology, i. e., three to the physiology of the normal individual and four to that of the pathological individual. Social psychology had an important place, while psycho-physics was relegated to the position of metaphysics in its importance to the Congress. This is very interesting to those who are concerned in the progress of psychology, because it corroborates what has been noted in every new monograph that appears in our current literature on the subject. The interest to-day in psychology is in its physiological aspects—normal and pathological—and to be added to this is a growing and healthy interest in social psychology.

The small space allowed to the history is natural: the science is young. H. Siebeck's prospected "Geschichte der Psychologie" would have ended without the most important chapter if it had been published entire with the first volume in 1884.

Psychology is making its history, and, therefore, it is the "new" psychology. The "new" psychology has its roots in the old, and yet they do not reach more than a hundred years back. The interest of the psychologist in the philosophical problems involved seems to be perennial. In an article that I wrote on the Congress at Munich, I expressed some fear in the great strength of metaphysics in the psychological world. At Munich that interest was paramount. My fear was not without reason at the time, but no bad results have materialized. Indeed, the psychological interest in philosophy, as seen in the subjects in the Congress of this year—La Conscience dans la psychologie moderne, Sieben Räthsel der Psyche, The Ultimate Guaranty of an Act of Memory, is healthful, and, indeed, necessary. The strict application of the scientific method to psychological data holds the metaphysics of the subject in check, and allows the two to run abreast in that natural way that makes a science vigorous. Metaphysics is always presupposed as the background of psychology.

* Some of the sessions have to be reckoned twice, since some were concerned with more than one subject, with subjects in their relations. Some papers were not read, but will be printed in the report.

The danger to psychology in 1900 is a different one from that in 1896. It is perhaps greater. Its present peril does not lie in an inclination to be deviated from its true subject matter and to roam about in metaphysical fields.

Psychology is inclined to shift its ground, to avoid and not persistently to overcome the difficulties confronting it; at least not frankly to acknowledge them insolvable and thereby to show what may and what may not be profitably studied. A science must progress if it be alive, but it cannot afford easily to forget its past and to leave no monuments to guide those who come after. The neglect into which psycho-physics has fallen is indicative of the caprice of this young science. Psycho-physics, or the experimental side of psychology—the aspect of the subject that was studied under artificial conditions in the laboratory—once was regarded as the beginning and the end of the science. The present congress devoted two sessions to it, which was the same amount of time as to the metaphysical aspect. Shall we call this movement away from psycho-physics and toward physiology and sociology cowardly? Not that quite. Nevertheless it smacks of that superficiality of the early Spanish explorer who claimed any territory upon which he stepped his foot and erected his cross. He left to others the harder work of organization. But can we truly say that the long and painstaking efforts of the psycho-physicist are fruitless? That, too, would be inappreciative and daring. The psychologist frequently becomes an apologist in the face of the usual question, "What has your science accomplished—anything?" He usually points in answer to the new methods adopted. But the results of psycho-physics are so unwieldy in the long tables of statistics, so complicated by hypotheses, and so indefinite on account of many vague data, that his reply carries little assurance. Not so much because psychology moves on, but because it plays the chambered nautilus and goes light-heartedly from one habitation into another, with its past as a burden on its back, does its great peril lie.

On the other hand, the fields that are now open are very fertile. It was indeed happy that the Congress should have been held in Paris at a time when sociology, physiology and especially pathology were matters of moment to it. The Frenchmen were the initial movers in physiological and pathological studies from the time when in 1795 Pinel at La Salpêtrière released the insane from their manacles. A long list of notable physiologists followed, and the French school has theoretically developed as well as practically used hypnotism to such a degree that it has become important in science and in human life.

It is not strange also that at this present moment the psychologist, who had trained his perception upon all possible subjects, should find also in the coming together and the movements of bodies of men an intense scientific interest. Sociology vies with physiology today in its claims upon psychology, even if the difficulties confronting the student of social psychology impede his progress and often stay his efforts. The interest in sociology from its economic and practical side in this present decade has inspired the purely theoretical interest; and the occasion and circumstances that have created a new political economy have also brought forth a new political psychology. The works of Le Bon on the Crowd, of Tarde Sidis, Baldwin and Royce, and the promised lectures of James on religion, are indications of a movement that had a very respectable recognition in the Congress of Paris. Papers by E. Ferri on Valeur collective des conditions économiques et des conditions psychologiques dans la genèse et l'évolution des phénomènes sociaux and by Dr. P. F. Eulenburg on the Problem der social Psychologie were assigned for the general session, and many communications were given in the subordinate sessions.

It must be remembered that the reasons for the pursuit of the mental sciences are not so obvious as those for natural sciences. A psychologist or metaphysician is ever confronted with a two-fold task. He must not only verify his data and demonstrate his conclusions, but he is also obliged to present proper credentials for his science existing at all. Psychology all the time has its social position brought into question. It is a rising upstart seeking a place among the old and blue-blooded nature-sciences. An international congress, like the one that met in August, has therefore a double task, and it may accomplish a double good. It is first an apologist and second a herald of the science it represents. It speaks therefore to the general public on the one hand and to the interested public on the other. It discusses and compares results for the benefit of the scientists themselves; it also announces to the public its continued prosperity and progress. In a word, the modern psychologist finds himself always obliged to answer first the question, "Is a science of psychology possible?" and secondly, "What are the results of such a science?" Yet it must be said that the new point of view toward mental phenomena is surely establishing itself, and to-day the credentials of psychology are far less often demanded than in the period just preceding the Munich Congress in 1896. It was a curious and a favorable sign of the times that the most mundane of the sciences—geology—was holding a convention in the same hall in Paris and during the same week.

In commenting on the Paris meeting, one could by no means overlook the thorough preparation that the French scientists had made for it, the extraordinary success of the session and the hospitality of the hosts. The three hundred and fifty members had their attention engaged day and night. Among the notable social events of the week were the receptions given by the vice president of the Congress, Mr. Richet, that of the Comité de l'Institut Psychique, that of the Prince Roland Bonaparte, and the usual banquet on the Champs Elysées. The Congress was also invited to visit many of the asylums, institutes, and sanatoriums in the vicinity whose inmates were of physiological and pathological interest. To be sure, the Paris Congress was not so thoroughly international as that of Munich. One missed the faces of many of the notable Germans. Only one prominent Englishman was present. The meetings were none the less enjoyable because so thoroughly French, and all the notable French psychologists were in constant attendance—M. Ribot, Richet, Janet, Alcan, Tarde, Bernheim, Bergson, Flournay and Toulouse. Profs. Münsterberg, Ladd and Warren were among the distinguished representatives from America. The next Congress meets in Rome, and in view of the vigor that the young science to-day displays, we may look for interesting developments in the meantime.

RENDERING THE WATER OF THE SEINE WHOLESOME.

UP to 1867, the Seine, in its passage through Paris, received all the liquid sewage and all the refuse of the city. This state of things was bad enough, even of old, when the population was small, since most of the inhabitants obtained their supply of water from the river; but later on, after the city had greatly increased in size, and especially in the latter part of the century just closed, it became a serious menace to the health of the public.

This danger was seen as long ago as 1855 by Haussmann, when, occupying himself with the subject of supplying Paris with potable water, he decided upon the construction of a system of sewers, of which the water was to be received by two large collectors emptying into the Seine, not at Paris, but at Clichy, below the Asnières bridge. Another one, called the collector of the North, was to lead the water from Belleville and Montmartre to the river at Saint Denis. The execution of these projects, which was not finished till 1867, assured the cleanliness of Paris, but not the wholesomeness of the Seine. The application of the principle of leading "everything into the sewer" served only to increase the contamination of the river. It therefore became necessary to do away with this permanent menace to the health of the public and to find a means that should assure of the purification of the liquid sewage before its entrance into the river.

In 1864, Mille, foreseeing the deplorable consequences of the influx of the foul water of the city into the Seine, proposed the adoption of the system of agricultural purification that he had seen in successful operation in other countries.

In the train of some experiments made at Clichy in 1866, the municipality of Paris acquired, at the entrance of the plain of Gennevilliers, a field of six hectares over which was distributed a portion of the water of the Asnières collector. These experiments were crowned with success and showed that the water collected in the drains was limpid and cool and free from microbes and organic matter, so that its entrance into the Seine no longer presented any danger.

Owing to the results obtained, it was decided to apply the system recommended by MM. Mille and Durand-Claye upon a large scale and to lead the water that could not be used by the cultivators of Gennevilliers to the gravel beds of Achères. But, as a consequence of the opposition of the department of Seine-et-Oise, the law authorizing the work was not passed till 1889. This law limited the quantity of water to be annually distributed to 40,000 cubic meters per hectare, and the concession granted upon the territory of Achères to 800 hectares. This irrigatable superficies was increased to 1,000 hectares through the acquisition by Paris of a neighboring domain called Tonceaux. This area, however, was still inadequate, and so a law passed in 1894 authorized the execution of new projects comprising the prolongation of the Achères aqueduct and the addition to the distributing fields of the irrigation fields of Mery-Pierrelaye and Carrières-Triel. The total area of the distributing fields was thus increased to 5,000 hectares.

This granted, let us see how the different distributing fields are supplied.

The starting point of the general drain is the Clichy works, where three large collectors debouch: the collector of Asnières, which, in addition, receives a portion of the water of the left bank through the Concorde siphon; the Marceau collector, which traverses the Seine at the Alma bridge; and the collector of the North, the water received by which is diverted at the Chapelle gate by two sewers that traverse Saint-Ouen and is led to the plain of Gennevilliers through gravity solely by four conduits that cross the Seine. From the Clichy works, the water is forced partly to Gennevilliers, where it is utilized, and partly toward the Colombes works. It crosses the Seine through a siphon of 3 meters internal diameter and 468 meters in length, and beginning at the bottom of a well 24 meters in depth. At first almost horizontal under the bed of the river, it reaches the level of the ground in the plain of Asnières through a long ascent.

Upon reaching the Colombes works, the water is raised by pumps, which, after sending it across the Seine through the four steel conduits, forces it to an altitude of 60 meters above the level of the sea, thus permitting it to reach the plain of Pierrelaye without a new elevation, and to be distributed in the valley of the Seine as far as to the vicinage of Mantes.

In the gallery of Argenteuil there are two force pipes, 1·8 meter in diameter. One of these is wholly of steel, and the other is partly of steel and partly of protected cement. Starting from the upper point, these two pipes unite to form a single circular aqueduct of 3 meters diameter, which, running along the right bank of the Seine, passes through Cormeilles, La Frette, and Herblay.

At Herblay, upon the left is detached the Achères branch, which crosses the Seine as a siphon and ends at the distributing system, and, upon the right, the Mery branch, which ends at the Pierrelaye works, which raise the water toward the distributing field of Mery-sur-Oise.

Finally, continuing its route, the principal drain traverses, through a force pipe 2 meters in diameter, the valleys of Chennevières and Oise, and, through the Hautie tunnel, reaches the commune of Triel, where it terminates provisionally. The Carrières branch, which starts from the tunnel at the level of Chanteloup, leads the sewage water to the municipal domain of Gresillons.

The general drain is 28 kilometers in length from the Clichy works. It supplies 9,000 hectares of irrigatable land and is capable of discharging 9·75 cubic meters per second, say about the double of what is furnished at present by the collectors of Paris.

The work as a whole of rendering the water of the Seine wholesome involved an expense of 38,000,000 francs, and was inaugurated July 8, 1899.

THE PUMPING WORKS.

We have seen that with the exception of the collector of the North, which, owing to its altitude, permits the

waste water that it receives to reach, through gravitation alone, the plain of Gennevilliers, where it is utilized, the great Parisian collectors all terminate at Clichy, where pumps direct the sewage water partially upon Gennevilliers and partially toward the Colombes works.

The Clichy works, constructed at the time of the first experiments made by the city of Paris for the agricultural utilization of the waters of its sewers, supplied

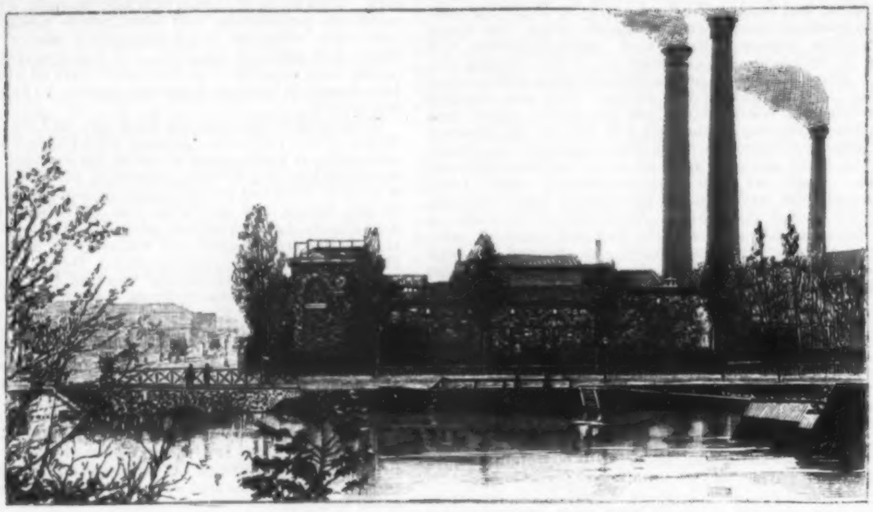


FIG. 1.—EXTERNAL VIEW OF THE CLICHY WORKS.

the territory of Gennevilliers as long ago as 1873, but had to be completely transformed in 1894, when the Achères service was created.

The old works comprised four groups of generators, motors, and pumps installed by the Farcot establishment of Saint Ouen. The generators, eight in number, were semi-tubular, with a feed-water heater. The motors, of the Corliss condensation type, were horizontal and provided with a single cylinder and four distributers. The centrifugal pumps, with vertical axis, were actuated through the intermedium of a spur wheel and pinion.

This installation permitted of lifting 100,000 cubic meters of water per day of 10 hours to a height of about 12 meters. This sufficed for the plain of Gennevilliers, but became inadequate when the city of Paris decided to conduct a portion of its sewage water to Achères.

The water designed for the new purifying fields had to be raised to a height of 48·5 meters above the level of the collectors upon reaching Clichy, and this would have necessitated a considerable pressure in the force pipes. As these latter passed through the communes of Asnières, Bois-Colombes, and Colombes, which were thickly inhabited, they would have perpetually menaced the residents of these localities with accidents. In order to do away with such inconveniences, Engineer in Chief Bechmann decided upon the installation at Colombes, upon the edge of the Seine, of intermediate works capable of giving the water derived from Clichy the pressure that is needed to cause it to reach Achères. The new service that the old works were to furnish consisted therefore in raising a volume of water greater than that which it was already forcing toward Gennevilliers to a height of about 5 meters.

Consequently, centrifugal pumps were indicated, since for the raising of large volumes of water to small heights, especially when the liquid is charged with substances in suspension, such pumps give a rendering much superior to that of piston pumps. On another hand, the progress that had been made in the construction of motors, since the first installation, permitted of replacing the control by gearings (which are noisy and fragile) by a direct control by employing rapidly running and less cumbersome engines.

At Colombes, on the contrary, since the height to which the forcing was to be done exceeded 40 meters, it necessitated the use of piston pumps, which have to run slowly in order to furnish a good rendering. It was therefore possible to use the old motors of Clichy for actuating them.

This granted, let us see how the new works operate.

1. The Clichy Works.—The Parisian collectors empty into what is called a settling basin, which is 60 meters in length, 10 meters in width and 4 in depth. In this are deposited the heavy materials held in suspension in the water. These substances are removed, in measure as they deposit, by means of an electric crane and a dredger with hinged jaws, and are loaded upon boats which enter the works through a small lateral canal.

This canal is separated from the settling basin by a waste weir over which the sewage water passes when the discharge of the collectors exceeds the requirements of the fields over which the sewage is distributed. But this is an exceptional case only, and occurs principally after heavy rains.

The settling basin comprises six galleries corresponding to the six pumps of the works. The sewage water, before entering the suction pipes, is freed from the floating bodies that it contains, such as straw, vegetable debris, etc., by means of stationary gratings cleaned automatically by means of combs. These throw the substances that they remove upon a movable board, which leads them to a wharf. After traversing these gratings, the water enters the suction pipes, properly so called, and then the pumps. These latter are centrifugal ones, with vertical axis, of the Farcot system, applied in Egypt at Katatbeh for the irrigation of Behera, and in France for the drainage of the marshes of Fos and La Crau (Bouches du Rhone). The four oldest pumps have a diameter of 1·92 meter and discharge from 2,000 to 2,500 liters per second, at a velocity of from 110 to 115 revolutions per minute, in forcing the water to Colombes. The two others, which are smaller, are but 1·6 meter in diameter and are capable of lifting 800 liters per second to a height of 10·5 meters upon Gennevilliers. These various pumps, placed below the engine room, have their movable parts balanced and supported by steel and bronze disks forming a pivot at the upper part of the arch of the frame, without a lower support. The shaft of each pump, which, in addition, carries a horizontal fly-wheel, is directly actuated by the piston rod of the motor.

The engine room contains six motors. Those that actuate the four large pumps are Farcot horizontal condensation engines with slide valves and variable expansion. Steam is furnished to them by five semi-tubular boilers registered at 6·5 kg. The two other engines, built by the Forges at Chantiers de la Mediterranée, are horizontal condensation ones with triple expansion. They run at the rate of from 118 to 135 revolutions per minute and receive steam from three generators analogous to the preceding, but registered at 11·25 kg. The water of condensation reaches the boilers after passing through a steam drier that raises its temperature to nearly 100° C.

The six force pipes are provided with sliding valves that permit of directing the water, as need be, either into the wall at the bottom of which the Colombes conduit begins or into a reservoir at about 10 meters above the settling basin, whence it flows to the fields of the plain of Gennevilliers.

2. The Colombes Works.—The water from Clichy empties, at the Colombes works, into vast settling basins in which are deposited the materials that it may still hold in suspension and those derived from the communal sewers of the region. An electric rolling bridge permits of the removal of the mud from the basins by means of dredgers, which empty into cars or boats. The cars are hauled by an electric locomotive. The electricity necessary for these maneuvers and for the lighting of the works is furnished by a small installation in which the dynamos are actuated by Laval steam turbines.

After the water has been freed from the materials in suspension, it is sucked up by the lift-pumps. Since these latter, as above stated, have to force the water to a manometric height of about 42 meters, they are of the double horizontal type with multiple check valves. Each pump chamber contains twelve check valves with external spiral springs. The piston has a diameter of 0·575 meter and a stroke of 1·8 meter, equal to that of the motor with which it is directly connected.

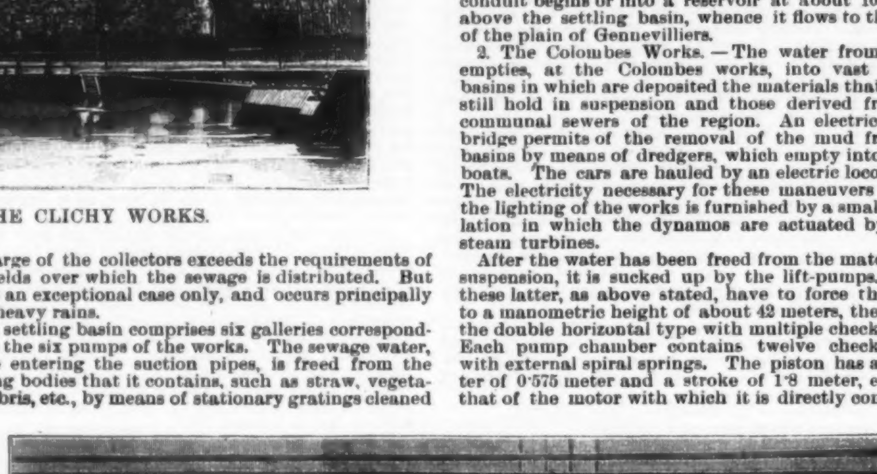


FIG. 2.—INTERNAL VIEW OF THE CLICHY WORKS.

Its mean velocity varies from 2·1 to 3·3 meters per second.

The engine room, which is 39 meters in length by 34·7 in width, and 16 in height, contains 12 groups of pumps and motors. The first four were constructed by the Farcot establishment, and each of them is of about 300 horse power. The eight other groups were furnished by the Fives-Lille works and are analogous to the preceding. The new motors, however, are more improved than the old ones. They are of the Corliss type modified, and each of them is capable of furnishing 380 effective horse power at a velocity of 35 revolutions per minute, with an admission of $\frac{1}{8}$ of the stroke of the piston, under an initial pressure of 7 kilogrammes upon the latter.

The discharge of the pumps is likewise a little greater. While each of the first four groups is capable of raising 500 liters per second, or say, altogether, 172,800 cubic meters per 24 hours, each of the eight other groups is capable of discharging 633 liters per second, say, altogether, 437,600 cubic meters per 24 hours. The boilers are 20 in number, 8 of them of the Farcot type with dismountable furnace and tubes, and 12 of them of the Niclausse type furnishing steam to the groups constructed by the Fives-Lille establishment.

Important work is now under way in view of the construction of a new engine and boiler room designed to complete the already important installation of Colombes.

3. The Pierrelaye Works.—Finally, there exists at Pierrelaye a third intermediate works designed for raising the water desired from the general drain for the irrigation of the 1,200 hectares situated in the region of Mery. These works embrace three groups of engines and pumps designed for raising 1,200 liters of water per second, say 100,000 cubic meters per 24 hours, to heights varying from 25 to 35 meters.

The motors are horizontal, of the Corliss type, with four slide valves and a steam jacket. They are of 162 horse power and their normal velocity is 32 revolutions per minute.

The pumps are piston ones with two simple-acting chambers and multiple check valves (38 for suction

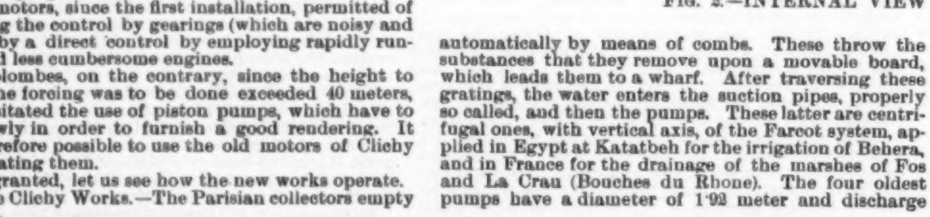


FIG. 3.—INTERNAL VIEW OF THE COLOMBES WORKS.

and 40 for forcing). They present the peculiarity that the weight of the piston is balanced by means of water under pressure.

The boilers, which are registered at 7·5 kilogrammes, are of the ordinary tubular type with interior furnace, back flame, and feed-water heater.—For the above particulars and the engravings, we are indebted to La Nature.

THE LAST DAY OF A FARM HOUSE AT POMPEII.

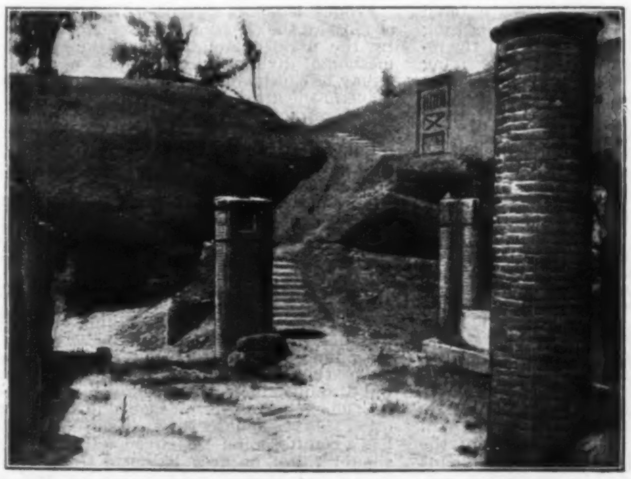
THE farm house of Cæcilius Aphrodisius was situated at a little over a mile from Pompeii, toward the north, upon the last undulations of Vesuvius. Like all the villas of the rural regions of Naples, it was pretty and attractive. It was lost in the midst of immense vineyards, surrounded with woods of olive and orange trees, shaded by parasol pines, laurels and myrtles, and perfumed with the odor of roses and violets. It was one of the handsomest farm houses of the delicious Campania. From the terrace, the view extended far away over the whitish mass of the neighboring city, over the verdant plain, and over the glistening mirror of the Gulf of Naples. It seemed as if here everything conspired to render life peaceful and happy.

On the 23d of August of the year 79 of our era, the sun had risen radiant and the day promised to be a splendid one and favorable for the ripening grapes. Aphrodisius, called to Naples by his business, had taken his departure from the country a few days previous, but had left as his substitute his manager and associate, Claudius Amphion, who, like himself, was a freedman, and a person whose fidelity and intelligence he had for a long time put to the test.

On that morning, Amphion had risen early, from having been disturbed by the noise of the slaves who were going to their work. His apartment was situated at the front of the house over the gateway. He had heard the removal of the bars of wood that assured the internal fastening of the gates, and the sound of the valves swinging upon their hinges. A cart had rumbled noisily over the roadway, and a day-laborer in search of work had rung the bell that hung at the side of the gateway. Amphion went down stairs in order to make his circuit of morning inspection.

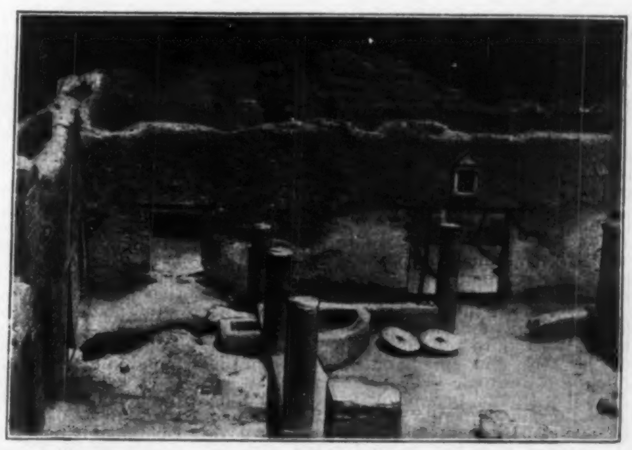
The internal courtyard of the farm house was surrounded on three sides with a portico, that is to say, with a walking-place open upon the courtyard and protected against the rain by a sloping roof resting upon brick pillars. Looking out upon the portico, which was furnished with cases and closets in which were locked up the kitchen utensils and table ware, there was a certain number of apartments. Amphion directed his steps in the first place toward the porter's lodge. In front of the door, the watch dog rose at his approach, and, shaking the chain by which he was fastened, came forward to caress him at the passageway. Amphion stroked the animal with his hand and entered. The slave Januarius, seated upon a cloth-covered board that did duty as a bed, in a corner of the room, was finishing a frugal repast. At a sign from the steward he rose, took a large bunch of keys and prepared to follow him. Both rapidly passed, without entering it, a sort of saloon or parlor, and then turned to the left into a narrow passageway that led to the kneading-trough. Here one of the slaves was kneading dough, while another was preparing to heat the oven. Amphion, after addressing a few words to them, retraced his steps and re-entered the courtyard. A door presented itself to him, and Januarius opened it. The room contained a full supply of tools. Spades, hoes, plowshares, scythes and pruning knives were lying upon the floor or hanging from the wall by pegs. Everything was in perfect order.

Afterward came another room, the kitchen, guarded by a second chained dog. Amphion, upon entering it, invoked the lares or domestic gods, the protectors of the house, the image of which was painted in a niche upon the rear wall. Tyche, a woman still young, was sitting squat near the furnace, in the center of the room, awaiting the orders of the manager. The latter,



REMAINS OF THE GATEWAY OF THE FARM HOUSE.

(View taken from the rear of the courtyard.)



THE INTERIOR COURTYARD OF THE FARM HOUSE.

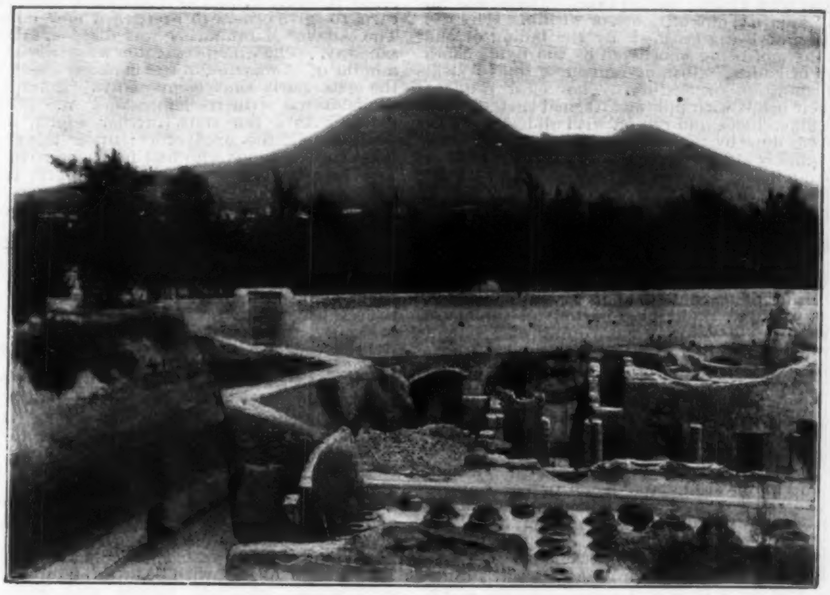
(Present state.)

without stopping, entered a small chamber, to the left of the kitchen, in which was arranged another furnace surmounted by two large leaden cylinders, one set into the other. In these, cold water from the kitchen collected and afterward flowed into the contiguous bath room, after it had been heated. Amphion ordered the fire to be lighted, and then, passing through the kitchen, entered the neighboring woodhouse, and thence proceeded to the stable. Out of the seven horses belonging to the farm, four had already gone out, and but three occupied their stalls. In an empty stall, a sow, surrounded by her litter saluted the visitors with grunts, while some startled hens set up a cackling and dispersed in every direction. The steward found that the mangers were full, assured himself that one of the horses that had been wounded in the withers was in a fair way of recovery, and then went out for a moment through a door that looked out upon the open country.

"Master," said Januarius to him, "see how Vesuvius is becoming covered with fumes. I have never seen any so dense since the great earthquake of February, which thou hast not forgotten. One would say that misfortune was preparing to smite us again."

"May the gods avert the presage," answered Amphion. "As for us, let us think of our duty, and allow destiny to act."

Then they re-entered the house and continued their



THE CELLAR OF THE FARM HOUSE AFTER THE WORK OF EXCAVATION.

rounds. They had now reached the door of the wine-press. This consisted of a large chamber divided into three parts: in the center, a plane space of which the floor, made of beaten clay, was covered with lime; and to the right and left a cement platform higher than the central part. The vintage was nigh, and the grape presses were in process of arrangement in the chamber. Between strong uprights fixed in the floor there had been placed the large beams designed for compressing basketfuls of grapes, and the windlasses for setting the beams in motion; for wine was made on Aphrodisius's farm in this way: The juice of the grapes, expressed by the beams, spread over the two cement platforms, at the edge of which it was arrested by a small gutter and through this was led to the basement, which was converted into a vast cistern. Terra cotta amphoræ, leaning against the wall at the rear of the chamber, were ready for the reception of the first specimens of the new wine. But the activity of the people of the house on this particular morning had been especially exerted in the contiguous chamber, that which faced the press room, in the wine cellar. There were a dozen slaves occupied here. Amphion could not prevent his eyes from resting with satisfaction upon the number of vessels that the room contained. Sunk in the earth and arranged in ten rows, there were nearly eighty of those immense jars that the Romans employed for the preservation of oil and wine, so that the cellar, when full, contained a supply of about 20,000 gallons. At this epoch, but half of the vessels were full, and it was in getting the others ready that the slaves were busy. It was necessary to remove the impurities deposited at the bottom, to stop up the fissures with cement and strengthen the receptacles containing cracks with cramps sealed into the terra cotta. The sun inundated the wine cellar (since the latter, according to the Campanian custom, was left open at the top in order to favor the aeration of the wine) and, under its rays, the slaves pursued their labor in singing, since the vintage is always a new fête for farms and their inhabitants.

Amphion, satisfied with their activity, was about to retire, when he heard a wagon entering the barn behind the wine cellar. This was driven by slaves, who had started out at day-break and who were bringing to the farm house immense bunches of bean and chick-pea plants plucked on the eve of the previous day. Of these they made piles here and there along the wall, leaving to the women the work of shelling after the pods should have become dry.

"Master," said they to Amphion, as soon as they saw him approaching, "the whole country is in a flurry, Vesuvius is belching forth a dense smoke, what is going to happen?"

"Cowards," answered the manager, feigning indifference, "go back to the fields; you have still time to make a second trip before dying. Come, my boys, drive on!" Having said this, Amphion immediately made his exit through the courtyard, and then, walking along the entire extent of the front of the house, entered through the gateway and regained his apartment, while Januarius returned to his lodge.

. . . .

Januarius had told the truth, and the peasants had good reason for being excited. The summit of Vesuvius was now surrounded with dense fumes. At every instant, a new column of smoke arose in the air, as if impelled by a blast emanating from the crater, spread out like a cloud and gradually covered the entire heavens. It might have been said that a dense fog was advancing from the horizon. The song had ceased in the wine cellar, and the slaves who had returned to the barn a second time with a new load had seated themselves on the ground in the courtyard and were regarding the mountain with inquietude.

All at once a squall of burning wind struck the farm house, while a shower of ashes enveloped it, and covered the earth, the roofs and the floors, entered through the open doors and windows, and penetrated every one's throat and nostrils. It was possible for the farm hands to preserve themselves from it only by shutting themselves up in well closed rooms. Some took refuge in the barn, and others in the press room. Januarius found a shelter in his lodge, and Amphion in his apartment. All, however, hoped that the storm that was passing would be promptly stilled. One circumstance at first seemed to decide in their favor, and that was a calm that soon occurred. All then recovered confidence and went out to examine the state of the sky.

The weather was all the time cloudy, the air was on fire, and Vesuvius, concealed under an impenetrable veil, was invisible. Nothing was perceived in its direction but sudden conflagrations and fitful glimmers that lighted the clouds of smoke for an instant and immediately disappeared. The road that skirted the farm house was filled with fleeing people—the inhabitants

of the farms nearer the volcano who had deserted their dwellings. They had piled up their most valuable and necessary objects in all haste upon carts, had seated the women and children thereon, and were making their way toward the coast in order to seek there a shelter against the scourge, or even a means of reaching more hospitable shores. The men—the slaves and day laborers—themselves loaded with whatever they could carry, followed the vehicles.

Meanwhile, the ashes, burning-hot, began to fall again, this time much more thickly and mixed with calcined stones. Under this new shower, the cries redoubled upon the road, and in the farm house all regained their shelter. But this time the heavens left no respite; the ashes became denser and the stones larger and more numerous; and, as if to add still another catastrophe to so many misfortunes, the walls were shaken by a violent earthquake. There was no longer any security out of doors or within. Here the risk was run of being crushed by the falling of the roofs and there of being smothered by the flying ashes or showers of stones. Nothing remained but to yield to one's inspiration or destiny. The most prudent covered their heads with pillows attached thereto with pocket handkerchiefs, and ran off with all haste. This was what was done by the slaves in the barn, and done none too quickly either, since scarcely had they taken flight when a fire broke out in the hay and in the plants that had been brought in in the morning. A few other persons followed their example. The only ones who stood by the manager were Januarius, two servants and Tyche, the kitchen maid. A council was held as to what should be done. Should the farm house be abandoned to thieves, who would profit by the general disorder to loot the dwellings? Amphion could not consent to this. He had the custody of the house and of everything of value that it contained. Should the party remain shut up in these chambers, which ran the risk of falling in or of catching fire? The surest thing was to abandon the first story and take refuge in the basement—in the press room, which was more spacious, more solidly constructed and better sheltered, and there await the end of the tempest.

Every one immediately went to work. One ascended to the master's apartments and took therefrom a large bed and its coverings and made preparations to let it down. The manager would lie upon this, while the others would stretch themselves out upon the floor. A second brought a bronze candelabrum from which were suspended lamps of the same metal. This at night would light up the improvised retreat. Januarius went and got a table and placed thereon a few plates and vessels to permit of preparing repasts should the imprisonment be prolonged. Tyche gathered together some loaves of bread and other food for the besieged, for it was a true siege that was to be suffered—that of ashes and lava. Amphion for his part had other occupations. The master of the farm house had confided to him a trust of great value—his silver plate, his valuables and his wife's jewelry. Whatever the cost, he had to place these in safety, and secure them from the wrath of the volcano as well as from the cupidity of man. The only thing that occurred to him was to carry them to the wine-press room. The number of trips was of little consequence. Ten times did he return to his room, ten times did he fill a basket with these precious things, and ten times did he cross the courtyard and porticoes with his burden, each time blinded by smoke and stifled by the ashes that filled the air. Finally, he had deposited everything in safety in a corner of the room. Then he shut the heavy oak door that closed the entrance, seated himself upon the bed surrounded by his three companions in misfortune, and awaited the end of the catastrophe, deliverance or death.

Januarius had never desired to share this asylum. His place was in his lodge, which he believed to be sufficiently protected. It had, moreover, the advantage of communicating with a door formed in the lateral face of the farm house looking toward the open country. In it, in case of absolute necessity, lay a supreme hope of safety. But, at the very moment that he was about entering it, the roof of the portico that skirted the courtyard, consumed by fire, fell in with a crash, crushed the watchdog that was howling at the entrance, and obstructed the opening with flaming rubbish. He had scarcely time to jump into the contiguous parlor, which was not a very sure asylum, since it was an open room separated from the exterior by a simple cloth curtain. The volcano had already deposited upon the floor of this a thick stratum of ashes, and it became necessary for him to get out of it as quickly as possible under the penalty of being buried alive in it. Januarius seized two iron wedges which happened to be in the room, and, using one of these as a hammer, tried to form a breach in the partition that separated the chamber from his lodge. He hoped if he succeeded in thus forming a passage for himself that he might through it reach the door that opened upon the country. But the wall was solid and the tools were powerless. After much obstinate labor, he scarcely succeeded in detaching the mortar from the wall and in making an incision in the first course of bricks. The fire had consumed the portiere and reached the furniture, the air was foul with sulphur, and it was impossible to remain there. The unfortunate man abandoned his tools and sprang outside through the smoking debris of the roof. The passageway that led to the kneading trough presenting itself to him, he entered it like one in desperate straits. Scarcely had he taken a few steps therein when his strength gave way, and he rolled upon the ground dying with asphyxia, his head buried in the burning dust.

And for three days Vesuvius continued to pour a deluge of incandescent material over the region. The courtyards, the chambers and the different parts of habitations were gradually filled with ashes, stones and objects in fusion. On the second day, this mass reached the level of the first story, and on the third it had overtopped the roofs. The rich exploitation of Cæcilius Aphrodisius had disappeared like its neighbors, and like the city of Pompeii itself, under a layer of ashes 23 feet in depth.

. . . .

In September, 1894, seventeen hundred years later on, a land owner of Bosco Reale, Signore di Prisco (successor to Aphrodisius), to whose kindness we owe the photographs that illustrate this narrative, undertook to remove the rubbish from the Roman farm house buried beneath his garden. The excavations were continued for two years. Every day brought with it new discoveries. Everything was found in its ancient place and in the state in which the volcano surprised men and things. One might say that the catastrophe dated from yesterday. The bell was still hanging from the jamb of the entrance gate, the closets in the porticoes of the courtyard, consumed by contact with hot stones, had left their form so sharply marked in the ashes that it sufficed to run plaster therein in order to obtain a faithful image of what they were of old; the skeletons of the dogs, with collars about their necks, lay in front of the porter's lodge and the kitchen; the horses were still attached to their manger in the stable; the swine were lying before their trough; and the hens were scattered in the wood house or in some corner of the dwelling. The heating apparatus seemed to be ready to operate, just as if Amphion were about to return to give orders to prepare a new bath for him. The cadaver of Januarius was discovered in the passageway. The wine-press room was entered, and in the middle of it was found the manager's bed, or at least the metal parts that composed it. Behind it was the candelabrum with its lamps and the table with its plates. At a few steps further along, an affecting scene struck the excavators; upon the ground were lying three persons who had fallen one over the other. The first, stretched out at full length, seemed as if peacefully sleeping. Death had come to him gently and easily. Near him, her head resting upon her side, lay a woman bent double. Finally, the third victim, a man, lay upon his belly, with his arm extended and fist clenched. In vain had he concealed his mouth and nose under a fold of his garment in order to protect them against the suffocating emanations. Asphyxia supervened, cruelly and inevitably.

Finally, the mouth of the cistern which extended under the wine-press room was reached. It was on the eve of Easter, at about five o'clock in the afternoon. The work was finished, and the laborers were chatting while taking a rest. One of them, Michele, conceived the idea of entering the basement through the yawning aperture, into which he easily slid, since the ashes had left it nearly unobstructed. His companions had hardly lost sight of him when they heard a loud cry of mingled admiration, amazement and horror.

At the bottom of the cistern, carefully arranged against the wall, and covered with a fabric that had been but slightly affected by the ravages of time, appeared forty silver vessels placed in two or three rows. There were plates with beautiful figures in repoussé, ornamented canthari, spoons with elegant curves, pateræ and salt cellars. In front, there were still other vessels of bronze and silver trays. Finally, at the very entrance of the cistern, under the mouth, there was a skeleton lying stretched at full length. In one hand it held some gold bracelets and collars of exquisite workmanship, and in the other tightly grasped a purse in which a fissure had allowed of the escape of more than a thousand gold coins. This cadaver was that of Amphion. Seeing the ashes entering the wine-press room, he had desired to save the riches intrusted to his care. He had let them down into this cistern, which it seemed as if the catastrophe must spare; but the gods had condemned Pompeii and its riches and its inhabitants. He died from suffocation at the moment at which, in a last effort, he was about to put the entire fortune of his master in a safe place.

It is now a hundred and fifty years ago that the excavations at Pompeii were begun. Since the time of Charles III. (1748) they have been continued without interruption, with more or less activity, according to circumstances; quite dilatorily at first (from 1748 to 1806, vigorously during the French occupation of Naples, regularly after the return of the Bourbons, and scientifically after the accession of Victor Emmanuel, and especially since 1870. Out of the 7,116,500 square feet that the city covers, 3,762,500 have now been excavated. Each year has allowed us to get a further insight into ancient life. We have followed the inhabitants of Pompeii in succession to their forum, into the temples in which they adored their gods, into their city hall where their municipal council assembled, into their tribunals, into their basilica (commercial exchange) and into their markets. We have entered their theaters, their amphitheater, and their bathing establishments. We have gradually witnessed the reappearance of the city streets with their large paving stones worn by the wheels of carts, the public fountains, the walls covered with electoral posters, the private houses filled with mural paintings, objects of art or common utensils, the hostelries, the oil stores, the bakeries, and the shops of all kinds. We have discovered the cemeteries established along great highways that started from the city, and have found them filled with elegant tombs.

There have been brought to light the bodies of seven hundred Pompeiian men and women, some of whom had been asphyxiated during their desperate run through the streets of the city, and others of whom had been crushed by the fall of a wall or a column or smothered by ashes at the bottom of a cellar in which they had taken refuge.

But no discovery has presented the same interest and the same originality as that of the villa of Cæcilius Aphrodisius. It will be admitted that every one has found in it something to his advantage; to archæologists it has shown what a Roman farm house with all its dependencies was; to artists it has rendered a hoard of silver plate of the first rank; and to lovers of the emotional it has presented the elements of a poignant drama, which I have endeavored to reconstruct.—R. Cagnat, in Lectures pour Tous.

Small Electric Motors in Germany.—Consul-General Guenther reports from Frankfort, August 9, 1900:

Contrary to American practice, which seldom uses anything smaller than motors of 5 horse power for driving machine tools, says the Elektrotechniker, experience in Germany has shown that driving with small motors, despite their lower efficiency, may be more advantageous than driving with large ones. The ideal system of running is the separate motor system, by which each machine is run independently, and light loads thereby avoided. But the introduction of this system depends to a great extent upon the initial cost of installation. Success has been obtained with alternate-current motors of 2 horse power without commutators or brushes and without regulating resistance.

OPENING ASTRONOMICAL ADDRESS.

By Dr. A. A. Common, F.R.S., F.R.A.S., Chairman of the Department of Astronomy, Bradford Meeting of the British Association.

It has been decided to form a department of Astronomy under Section A, and I have been requested to give an address on the occasion. In looking up the records of the British Association to see what position astronomy has occupied, I was delighted to find in the very first volume "A Report on the Progress of Astronomy during the Present Century," made by the late Sir George Airy, so many years our Astronomer Royal, and at that time Plumian Professor of Astronomy at Cambridge. This report, made at the second meeting of the Association, describes, in a most interesting manner, the progress that was made during the first third of the century, and we can gather from it the state of astronomical matters at that time. The thought naturally occurred to me to give a report on the same lines, to the end of this century, but a little consideration showed that it was impossible in the limited time at my disposal to give more than a bare outline of the progress made.

At the time this report was written we may say, in a general way, that the astronomy of that day concerned itself with the position of the heavenly bodies only, and, except for the greater precision of observation resulting from better instruments, and the larger number of observatories at work, this, the gravitational side of astronomy, remains much as it was in Airy's time.

What has been aptly called the New or Physical Astronomy did not then exist. I propose to briefly compare the state of things then existing with the present state of the science, without dealing very particularly with the various causes operating to produce the change; to allude briefly to the new astronomy; and to speak rather fully about astronomical instruments generally, and of the lines on which it is most probable future developments will be made.

In this report (Brit. Assoc. Report, 1831–32, p. 125) we find that at the beginning of the century the Greenwich Observatory was the only one in which observations were made on a regular system. The thirty-six stars selected by Dr. Maskelyne, and the sun and moon, were observed on the meridian with great regularity, the planets very rarely and only at particular parts of their orbits; small stars, or stars not included in the thirty-six, were seldom observed.

This state of affairs was no doubt greatly improved at the epoch of the report, but it contrasts strongly with the present work at Greenwich, where 5,000 stars were observed in 1899, in addition to the astrographic, spectroscopic, magnetic, meteorological, and other work.

Many observatories, of great importance since, were about that time founded, those at Cambridge, Cape of Good Hope and Paramatta having just been started. A list is given of the public observatories then existing, with the remark that the author is "unaware that there is any public observatory in America, though there are," he says, "some able observers."

The progress made since then is truly remarkable. The first public observatory in America was founded about the middle of the century, and now public and private observatories number about 150, while the instrumental equipment is in many cases superior to that of any other country. The prophetic opinion of Airy about American observers has been fully borne out. The discovery of two satellites to Mars by Hall in 1877, of a fifth satellite to Jupiter by Barnard in 1892, and the discovery of Hyperion by Bond, simultaneously with Lassell, in 1848, are notable achievements.

The enormous amount of work turned out by the Harvard Observatory and its branches in South America, all the photographic and spectroscopic work carried out by many different astronomers, and the new lines of research initiated show an amount of enthusiasm not excelled by any other country. A greater portion of the astronomical work in America has been on the lines of the new astronomy, but the old astronomy has not been at all neglected. In this branch pace has been kept with other countries.

From this report we gather that the mural quadrant at most of the observatories was about to be replaced by the divided circle. Troughton had perfected a method of dividing circles which, as the author says, "may be considered as the greatest improvement ever made in the art of instrument making."

Two refractors of 11 and 12 inches aperture had just been imported into this country; clockwork for driving had been applied to the Dorpat and Paris equatorials, but the author had not seen either in a state of action.

The method of mounting instruments adopted by the Germans was rather severely criticised by the author, the general principle of their mounting being "telescopes are always supported at the middle, not at the ends.

"Every part is, if possible, supported by counterpoises.

"To these principles everything is sacrificed. For instance, in an equatorial the polar axis is to be supported in the middle by a counterpoise. This not only makes the instrument weak (as the axis must be single), but also introduces some inconvenience into the use of it. The telescope is on one side of the axis; on the other side is a counterpoise. Each end of the telescope has a counterpoise. A telescope thus mounted must, I should think, be very liable to tremor. If a person who is no mechanic and who has not used one of these instruments may presume to give an opinion, I should say that the Germans have made no improvement in instruments except in the excellence of the workmanship."

I have no doubt that this question had often occupied Airy's mind, for in the Northumberland equatorial telescope which he designed shortly after for Cambridge he adopted what has been called the English form of mounting, where the telescope is supported by a pivot at each side, and a long polar axis is supported at each end. This telescope is in working order at the present time at Cambridge.

When he became Astronomer Royal, he used the same design for what was for many years the great equatorial at Greenwich, though the wooden uprights forming the polar axis were in the Greenwich telescope replaced by iron. It says much for the excellence of

the design and workmanship of this mounting designed as it was for an object-glass of about 13 inches diameter, when we find the present Astronomer Royal, Mr. Christie, has used it to carry a telescope of 28 inches aperture, and that it does this perfectly.

Notwithstanding the greater steadiness of the English form of mounting, the German form has been adopted generally for the mounting of the large refractors recently made.

There is much interesting matter in this report of an historical character.

As I have already said, the new astronomy, as we know it, did not exist; but in a report (Brit. Assoc. Report, 1831–32, p. 308) on optics, in the same volume, by Sir David Brewster, we find that spectrum analysis was then occupying attention, and the last paragraph of this report is well worth quoting: "But whatever hypothesis be destined to embrace and explain this class of phenomena, the fact which I have mentioned opens an extensive field of inquiry. By the aid of the gaseous absorbent we may study with the minutest accuracy the action of the elements of material bodies in all their variety of combinations, upon definite and easily recognized rays of light, and we may discover curious analogies between their affinities and those which produce the fixed lines in the spectra of the stars. The apparatus, however, which is requisite to carry on such inquiries with success cannot be procured by individuals, and cannot even be used in ordinary apartments. Lenses of large diameter, accurate heliostats, and telescopes of large aperture are absolutely necessary for this purpose; but with such auxiliaries it would be easy to construct optical combinations, by which the defective rays in the spectra of all the fixed stars down to the tenth magnitude might be observed, and by which we might study the effects of the very combustion which lights up the suns of other systems."

Brewster's words are almost prophetic, and it would almost appear as if he unknowingly held the key to the elucidation of the spectrum lines, for it was not until 1859 that Kirchhoff's discovery of the true origin of the dark lines was made.

Fraunhofer was the first to observe the spectra of the planets and the stars, and to notice the different types of stellar spectra. In 1817 he recorded the spectrum of Venus and Sirius, and later, in 1823, he described the spectrum of Mars; also Castor, Pollux, Capella, Betelgeux and Procyon.

Fraunhofer, Lamont, Donati, Brewster, Stokes, Gladstone and others carried on their researches at a time when the principles of spectrum analysis were unknown, but immediately upon Kirchhoff's discovery great interest was awakened.

With spectrum analysis thus established, aided as it was later by the great development of photography, the new astronomy was firmly established.

The memorable results arrived at by Kirchhoff were no sooner published than they were accepted without dissent. The works of Stokes, Foucault, and Angström at that period were all suggestive of the truth, but do not mark an epoch of discovery.

Astronomical spectroscopy divided itself naturally into two main branches, the one of the sun, the other of the stars, each having its many offshoots. I shall just mention a few points relating to each. The dark lines in the solar spectrum had already been mapped by Fraunhofer, and now it only needed better instruments and the application of laboratory spectra with Kirchhoff's principle to advance this work still further.

Fraunhofer had already pointed out the way in using gratings, and these were further improved by Nobert and Rutherfurd.

Kirchhoff's Map of the Solar Spectrum, published in 1861–62, was the most complete up to that time; but the scale of reference adopted by him was an arbitrary one, so that it was not long before this was improved upon. Angström published in 1868 his map of the "Normal Solar Spectrum," adopting the natural scale of wave-lengths for reference, and this remained in use until quite recent times.

The increased accuracy in the ruling of gratings by Rutherfurd materially improved the efficiency of the solar spectroscope, but it was not until Prof. Rowland's invention of the concave grating that this work gained any decisive impetus. The maps (first published in 1885) and tables (published in the years 1896–98) of the lines of the solar spectrum are now almost universally accepted and adopted as a standard of reference. These tables alone record about 10,000 lines in the spectrum of the sun, which is in marked contrast to the number 7 recorded by Wollaston at the beginning of the century (1802). Good work in the production of maps has also been done in this country by Higgs.

Michelson has also recently invented a new form of spectroscope called the "Echelon" (Ast.-Phys. Journ., vol. viii., 1898, p. 37), in which a grating with a relatively small number of lines is employed, the dispersion necessary for modern work being obtained by using a high order (say the hundredth) into which most of the light has been concentrated.

Besides lines recorded in the visual and ultra-violet portions of the solar spectrum, maps have been made of the lines in the infra-red, the most important being that of Langley's, published in 1894, prepared by the use of his "bolometer." Good work had, however, been done in this direction previously by Becquerel, Lamansky, and Abney; the last, indeed, succeeded even in photographing a part of it.

The recording of the Fraunhofer lines in the solar spectrum is not all, however. The application of the spectroscope to the sun has several epoch-marking events attached to it, notably those of proving the solar character of the prominences and corona, the rendering visible of the prominences without the aid of an eclipse by the discovery of Lockyer and Janssen in 1868, the photography of the prominences both round the limb and those projected on the solar disk by the invention of the spectra-heliograph by Hale and Deslandres in 1890.

Success has not yet favored the many attempts to photograph the corona without an eclipse by spectroscopic means; but even now this problem is being attacked by Deslandres with the employment of the calorific rays.

Spectroscopic work on the sun has led to the discovery of many hundreds of dark lines, the counterparts of which it has not yet been possible to produce on the earth.

But besides those unknown substances which reveal their presence by dark lines, there were two others discovered, which showed themselves only by bright lines, the one in the chromosphere, to which the name of Helium was given, and the other in the corona, to which the name of Coronium was applied.

The former was, however, identified terrestrially by Ramsay in 1895, though the latter is still undetermined. The revision of its wave length, brought about by the observations of the eclipse of 1898, may, however, result in this element being transferred from the unknown to the known in the near future.

The study of the stellar spectra was taken up by Huggins, Rutherfurd, and Secchi. Rutherfurd (Am. Journ., vol. xxxv., 1862, p. 77) published in 1862 his results upon a number of stars, and suggested a rough classification of the white and yellow stars; but Secchi deserves the high credit of introducing the first systematic differentiation of the stars according to their spectra, he having begun a spectroscopic survey of the heavens for the purposes of classification (Comptes Rendus, t. lvii., 1853), while Huggins devoted himself to the thorough analysis of the spectra of a few stars.

The introduction of photography marks another epoch in the study of stellar spectra. Sir William Huggins applied photography as early as 1863 (Phil. Trans., 1864, p. 428), and secured an impression of the spectrum of Sirius, but nearly another decade elapsed before Prof. H. Draper (Am. Journ. of Soc. and Arts, vol. xviii., 1879, p. 421) took a photograph of the spectrum of Vega in 1872, which was the first to record any lines. With the introduction of dry plates this branch of the new astronomy received another impetus, and the catalogues of stellar spectra have now become numerous. Among them may be mentioned those of Harvard College, Potsdam, Lockyer, McClean, and Huggins. The Draper Catalogue (Annals Harvard Coll., vol. xxvii., 1890) of the Harvard College, which is a spectroscopic Durchmusterung, alone contains the spectra of 10,351 stars down to the 7–8 magnitudes, and this has further been extended by work at Arequipa, while Vogel and Müller, of Potsdam (Astro-Phys. Obs. zu Potsdam, vol. iii., 1882–83), made a spectroscopic survey of the stars down to 7·5 magnitude between —1° and +20° declination. This has again been supplemented by Scheiner (ibid., vol. vii., 1895: "Untersuchungen über die Spectra der helleren Sterne") and by Vogel and Wilsing (ibid., vol. xii., 1899: "Untersuchungen über die Spectra von 528 Sternen"). Lockyer (Phil. Trans., vol. clxxxiv. A, 1893) in 1892 published a series of large-scale photographs of the brighter stars, and more recently McClean (Phil. Trans., vol. cxci. A, 1898) has completed a spectroscopic survey of the stars of both hemispheres down to the 3½ magnitude. For the study and investigation of special types of stars, the researches of Dunér on the red stars, made at Upsala, and those of Keeler and Campbell on the bright line stars, made at the Lick Observatory, deserve mention. For the study of stellar spectra the use of prisms in slit or objective-prism spectroscopes has predominated, though more recently the use of specially ruled gratings has been attended by some degree of success at the Yerkes Observatory.

Several new stars have also been discovered by their spectra by Pickering in his routine work of charting the spectra of the stars in different portions of the sky. The photographic plate containing their peculiar spectra was, however, not examined in many cases until the star had died down again.

Spectrum analysis also opened up another field of inquiry, viz., that of the motion of the stars in the line of sight, based on the process of reasoning due to Doppler, and accordingly named Doppler's Principle ("Ueber das farbige Licht der Doppelsterne," . . . Abhandl. der K. Böhmischen Ges. d. Wiss. V. Folge, 2 Bd., 1843).

The observatories of Greenwich and Potsdam were among the first to apply this to the stars, and more recently Campbell at Lick, Newall at Cambridge, and Belopolsky at Pulkowa, have made use of the same principle with enormous success.

It was also discovered that there are certain classes of stars having a large component velocity in the line of sight, which changes its direction from time to time, and in many such cases orbital motion has been proven, as in the case of Algol.

Another class of binary stars has also been discovered spectroscopically and explained by Doppler's principle. I refer to the stars known as spectroscopic binaries, in which the spectrum lines of one luminous source reciprocate over those from the other source of light, according as one is moving toward or away from the earth. This displacement of the spectrum lines led to the discovery of the duplicity of β Aurigæ and ζ Ursæ Majoris by Pickering (Am. Jour. [3], 39, p. 46, 1890).

Several other such stars have now been detected, notably β Lyræ, and lastly Capella, discovered independently by Campbell (Astro-Phys. Jour., vol. x., p. 177) at Lick, and Newall (Monthly Notices, vol. lx., p. 2, 1899) at Cambridge.

The progress of the new astronomy is so closely bound up with that of photography that I shall briefly call to mind some of the many achievements in which photography has aided the astronomer.

Daguerre's invention in 1839 was almost immediately tried with the sun and moon, J. W. Draper and the two Bonds in America, Warren de la Rue in this country, and Foucault and Fizeau in France, being among the pioneers of celestial photography; but no real progress seems to have been made until after the introduction of the collodion process. Sir John Herschel in 1847 suggested the daily self-registration of the sun-spots to supersede drawings; and in 1857 the De la Rue photo-heliograph was installed at Kew. From 1858–72 a daily record was maintained by the Kew photo-heliograph, when the work was discontinued. Since 1873 the Kew series has been continued at Greenwich, and is supplemented by pictures from Dehra Dûn in India and from Mauritius. The standard size of the sun's disk on these photographs has now been for many years eight inches, though for some time a 12-inch series was kept up.

The first recorded endeavor to employ photography for eclipse work dates back to 1851, when Berowsky obtained a daguerreotype of the solar prominences during the total eclipse. From that date nearly every total eclipse of the sun has been studied by the aid of photography.

In 1860 the first regularly planned attack on the problem by means of photography was made, when De la Rue and Secchi successfully photographed the prominences and traces of the corona, but it was not until 1869 that Prof. Stephen Alexander obtained the first good photograph of the corona.

In recent years, from 1893 until the total eclipse which occurred last May, photography has been employed to secure large-scale pictures of the corona. These were inaugurated in 1893 by Prof. Schaeberle, who secured a 4-inch picture of the eclipsed sun in Chile; these have been exceeded by Prof. Langley, who obtained a 15-inch picture of the corona in North Carolina during the eclipse of May, 1900.

Photography also supplied the key to the question of the prominences and corona being solar appendages, for pictures of the eclipse sun taken in Spain in 1860 terminated this dispute with regard to the prominences, and finally to the corona in 1871.

In 1875, in addition to photographing the corona, attempts were made to photograph its spectrum, and at every eclipse since then the sensitized plate has been used to record both the spectrum of the chromosphere and the corona. The spectrum of the lower layers of the chromosphere was first successfully photographed during the total eclipse of 1896 in Nova Zembla by Mr. Shackleton, though seen by Young as early as 1870, and a new value was given to the wave-length of the coronal line (wrongly mapped by Young in 1869) from photographs taken by Mr. Fowler during the eclipse of 1898 (India).

Lunar photography has occupied the attention of various physicists from time to time, and when Daguerre's process was first enunciated, Arago proposed that the lunar surface should be studied by means of the photographically produced images. In 1840 Dr. Draper succeeded in impressing a daguerreotype plate with a lunar image by the aid of a 5-inch refractor. The earliest lunar photographs, however, shown in England were due to Prof. Bond, of the United States. These he exhibited at the Great Exhibition in 1851. Dancer, the optician, of Manchester, was, perhaps, the first Englishman who secured lunar images, but they were of small size (Abney, "Photography").

Another skillful observer was Crookes, who obtained images of 2 inches diameter, with an 8 inch refractor of the Liverpool Observatory. In 1852 De la Rue began experimenting in lunar photography. He employed a reflector of some 10 feet focal length and about 13 inches diameter. A very complete account of his methods is given in a paper read before the British Association. Mr. Rutherfurd at a later date having tried an 11½-inch refractor, and also a 13-inch reflector, finally constructed a photographic refracting telescope, and produced some of the finest pictures of the moon that were ever taken until recent years. Also Henry Draper's picture of the moon taken September 3, 1863, remained unsurpassed for a quarter of a century.

Admirable photographs of the lunar surface have been published in recent years by the Lick Observatory and others. I myself devoted considerable attention to this subject at one time; but only those surpassing anything before attempted have been published in 1896–99 by MM. Loëwy and Puiseux, taken with the Equatorial Coudé of the Paris Observatory.

Star prints were first secured at Harvard College, under the direction of W. C. Bond, in 1850; and his son, G. P. Bond, made in 1857 a most promising start with double-star measurements on sensitive plates, his subject being the well known pair in the tail of the Great Bear. The competence of the photographic method to meet the stringent requirements of exact astronomy was still more decisively shown in 1866 by Dr. Gould's determination from his plates of nearly fifty stars in the Pleiades. Their comparison with Bessel's places for the same objects proved that the lapse of a score of years had made no difference in the configuration of that immemorial cluster; and Prof. Jacoby's recent measures of Rutherfurd's photographs taken in 1872 and 1874 enforce the same conclusion.

The above facts are so forcible that no wonder that at the Astrophotographic Congress held in Paris in 1887 it was decided to make a photographic survey of the heavens, and now eighteen photographic telescopes of 13 inches aperture are in operation in various parts of the world, for the purpose of preparing the international astrographic chart, and it was hoped that the catalogue plates would be completed by 1900.

Photography has been applied so assiduously to the discovery of minor planets that something like 450 are now known, the most noteworthy, perhaps, as regards utility being the discovery of Eros (433) in 1898 by Herr Witt at the observatory Urania, near Berlin.

With regard to the application of photography to recording the form of various nebulæ, it is interesting to quote a passage from Dick's "Practical Astronomer," published in 1845, as opposed to Herschel's opinion that the photography of a nebula would never be possible:

"It might, perhaps, be considered as beyond the bounds of probability to expect that even the distant nebulæ might thus be fixed and a delineation of their objects produced which shall be capable of being magnified by microscopes. But we ought to consider that the art is only in its infancy, and that plates of a more delicate nature than those hitherto used may yet be prepared, and that other properties of light may yet be discovered, which shall facilitate such designs. For we ought now to set no boundaries to the discoveries of science, and to the practical applications of scientific discovery, which genius and art may accomplish."

It was not, however, until 1880 that Draper first photographed the Orion Nebula, and later by three years I succeeded in doing the same thing with an exposure of only thirty-seven minutes. In December, 1885, the brothers Henry by the aid of photography found that the Pleiades were involved in a nebula, part of which, however, had been seen by myself (Monthly Notices, vol. xl., p. 376) with my 3-foot reflector in February, 1880, and later, February, 1886, it was also partly discerned at Pulkowa with the 30-inch refractor then newly erected.

Still more nebulosity was shown by Dr. Roberts's photographs (ibid., vol. xlvii., p. 24), taken with his 20-inch reflector in October and December, 1886, when the whole western side of the group was shown to be

involved in a vast nebula, while a later photograph taken by MM. Henry early in 1888 showed that practically the whole of the group was a shoal of nebulous matter.

In 1881 Draper and Janssen recorded the comet of that year by photography.

Huggins (Proc. Roy. Soc., vol. xxxii., No. 213) succeeded in photographing a part of the spectrum of the same object (Tebbutt's Comet 1881, II.) on June 24, and the Fraunhofer lines were among the photographic impressions, thus demonstrating that at least a part of the continuous spectrum is due to reflected sunlight. He also secured a similar result from Comet Wells (Brit. Assoc. Report, 1882, p. 442).

(To be continued.)

THE EFFECTS OF FRUITS AND VEGETABLES ON MILK, BUTTER, ETC., WHEN KEPT IN THE SAME ICE CHEST.

THAT sweet milk, exposed to the surrounding atmosphere, absorbs and holds with great tenacity the odors and emanations of other substances in the immediate vicinity, has long been generally known. The fact that cream, and butter, fresh or salt, and even ice-cream, have the same absorbent property, while also well known, does not seem to be appreciated to the extent that it should be among those charged with the conservation of such substances, as the following instances will show:

At a certain establishment in St. Louis, the writer recently obtained a dish of peaches and cream. On tasting the latter, it was found to have a disagreeable, nauseous flavor and a peculiar odor, reminding one somewhat of colocynth. Calling the attention of the attendant to the matter, he was at first quite sure that the taste and odor complained of were imaginary, and asserted that the cream came from a certain dairy, was delivered fresh twice daily, and in the meantime was kept in the ice chest, etc.

The attention of the proprietor being attracted by the discussion, he tasted the cream, and at once declared it spoiled. An examination of the ice chest showed that, along with the cream and milk, there was an assortment of edibles, including a lot of canteloupes, and that the entire stock of liquids was contaminated with the odor of the melons. There was plenty of ice in the chest, the latter was scrupulously clean, and the articles were kept at a temperature certainly under 45° F.

The matter set the writer to thinking, and he concluded to try a few experiments at home, with his own ice chest and table supplies. Into the chest, well stocked with ice, and containing the daily supply of milk and cream, the one in an earthenware crock and the other in a pitcher, and both open, he placed two fresh, sweet-smelling "Rocky Ford" canteloupes, closed the chest, and let it remain shut for a couple of hours. At the end of this time, the milk had a markedly foreign and unpleasant taste, not so pronounced, however, in the cream. Some freshly churned, unsalted butter, open in a saucer, and some salted dairy butter, in the original mould, were introduced, and the chest closed for the night.

On examination the next morning, the milk was found to be so strongly impregnated with an odor somewhat resembling spoiled canteloupe, that it was quite unfit for any purpose. The cream was also strongly contaminated, but not nearly to the extent of the milk. The salted butter had an unpleasant odor and a peculiar taste, both of which were confined to a layer on the surface, extending into the substance from one-eighth to one-quarter of an inch in depth. The fresh butter was a "revelation." When first taken out, hard and cold, it appeared to have merely lost the fragrance of sweet, fresh butter, and to have become nearly tasteless, but after standing and becoming soft, it gave forth a rank, nauseous smell, and was bitter and disgusting to the taste.

There being but a small amount of it, and being spread out on the saucer, the whole mass was permeated and rendered utterly unfit for human consumption. To test its effects upon the intestines, however, the experimenter forced himself to swallow about half of it—says two heaping teaspoonfuls. It left a "nasty" taste in the mouth, accompanied by a burning sensation of the fauces, which lasted for a couple of hours. The bowels, regular hitherto, were very much disturbed all the ensuing day, passing off several times, the actions being attended with more or less griping.

Not having taken the precaution of reserving a portion of each of the substances under observation for control purposes, the experiment was subsequently repeated, and with identical results as far as the dairy products kept in the presence of the canteloupes, while those reserved as control remained perfectly normal in every respect.

The writer then instituted a series of experiments with other fruits and vegetables usually kept in the ice chest along with butter, milk, cream, etc., with results similar in every respect, and varying only in degree. Thus, each by itself, cucumbers, tomatoes, peaches, pears and lettuce, were tried, and each was found to affect the taste and odor of the dairy products to a greater or less degree, but always deleteriously.

Wishing to see to what extent the milk, cream, etc., might be protected from contamination from other substances left in the refrigerator along with them, by covering the dishes in which the dairy products were kept, experiments were instituted and resulted in demonstrating that nothing short of closing the vessels air-tight was entirely successful. Putting the milk, cream, etc., into glass preserve jars, provided with screw covers fitted with rubber bands, and screwing the covers down tight, acted as a perfect protection, even when they were left in the box along with ripe canteloupes, which, by the way, of all substances experimented with, proved the most certain and the most disagreeable of contaminators.

Since the foregoing was written the writer has tested the effects of leaving dairy products open in the refrigerator, along with fresh meats (beef, poultry, etc.), and has found that but a few hours' exposure are sufficient to render butter, milk and cream unfit for consumption. Fresh meat, even when perfectly preserved itself, imparts a curious, sourish, unpleasant taste to all three substances. Fish, as might be expected, affected the products more rapidly and more deleteriously than fresh meat.

The experiments have fully convinced the writer that the dairy products and vegetables, fruits, etc., as well as meats, should not be kept in the same ice chest, even in separate compartments of the same. The ice chest, or so-called "refrigerator," used by the writer in his experiments, is an ordinary upright one, of hard wood, zinc lined, and divided into three intercommunicating departments.—National Druggist.

FRENCH LOCOMOTIVES AT THE EXPOSITION OF 1900.

As the exhibition of the rolling stock of the large French railway companies is fortunately in the vicinity of that of the transportation companies of less importance at the Vincennes annex of the Exposition, it permits of very instructive comparisons. Such a secondary company as that of Bône-Guelma, for example, shows its passenger cars alongside of those of the Company of the East, and allows it plainly to be seen that the Algerian material is admirably adapted to the exigencies of the climate and to the purposes for which it is designed. Let us recall the fact, by the way, that this Algerian company has maps of its system and admirably executed pictures on exhibition at the Champ-de-Mars.

The State Railways.—The State railways exhibit (1) a high-pressure and simple expansion locomotive for express and "lightning" trains; (2) a baggage-car-tender locomotive for light trains; (3) a high-speed locomotive with double expansion and distribution of the Vauclain system; and (4) a locomotive with cylindrical slide-valves of the Ricour system.

The high-pressure locomotive (of 14 kilogrammes per square centimeter at the cylinders) presents a form that has been studied with a view to diminishing the resistance of the air to as great a degree as possible while running. The locomotives of this type, which are designed more especially for rapid transit, currently haul a 220-ton (gross weight) train upon a horizontal stretch between inclines at a speed of 102 kilometers an hour. On a gradient of 10 millimeters, such speed drops to 70 kilometers. One of these engines, with a supply of 20 cubic meters of water, has traversed the distance of 326 kilometers that separates Paris from Thouars (without taking on water by the way) at a full speed of 85 kilometers between Paris and Royan. This locomotive, the type of which was established in 1896, is mounted upon two coupled axles and a jointed truck with lateral displacement that carries the front part. The fire-box is between the axles.

The driving wheels are 2·02 meters in diameter. The generator, with fire-box of the Belpaire type, with a grate surface of 2 square meters, consists of a cylindrical shell 1·38 meters in diameter, inclosing 111 tubes with heat-radiating flanges. The two simple expansion cylinders, which are 0·44 meter in diameter, are external and placed in front of the engine, between the wheels of the truck. The distribution is effected by means of cylindrical slide-valves of the Ricour type. This system of distribution is, as a general thing, that now applied to the engines of the State railways.

The weight of the locomotive is thus distributed: 30 tons upon the coupled driving wheels and 21 tons upon the truck wheels. The total weight in running order is 51 tons.

Baggage-Car-Tender Engine.—This engine, combined with a baggage car in order to permit of reducing the personnel of the engine to one man, is characterized by the mounting of a baggage car of reduced length upon the frame of the engine itself. Owing to such an arrangement, which puts the platform of the engineman and that of the baggage car upon the same level, the chief guard and the engineman are in immediate communication with each other. This powerful engine permits of varying the rate of running according to the profiles of the route, and hauls trains with moderate loads upon uneven profiles at the ordinary speeds of the passenger service, while at the same time it easily lends itself to a speed of 75 kilometers per hour in hauling 70 tons upon a level.

The distribution through cylindrical slide-valves is controlled by a connecting-link of the Walschaert's type. The total weight, in running order, is 33 tons, and the driving wheels are 1·32 meters in diameter.

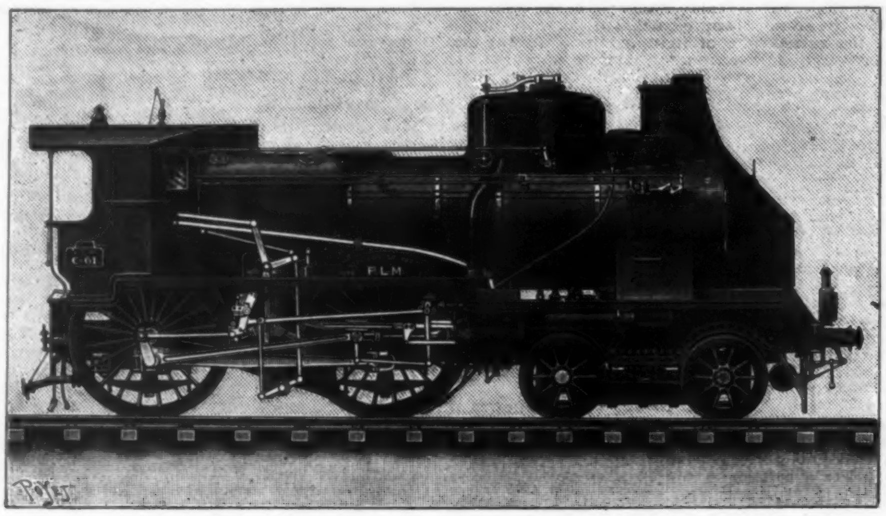


FIG. 1.—A HIGH-SPEED LOCOMOTIVE OF THE PARIS-LYONS-MEDITERRANEAN RAILWAY.

The State railways also exhibit a locomotive of a new type, constructed at Philadelphia in 1900. This engine, which is a double-expansion one, is mounted upon a truck provided with four coupled wheels of a diameter of 0·914 meter. Since the engine is designed for hauling express trains, it is provided with driving wheels 2·14 meters in diameter.

The boiler, registered at 15 kilogrammes, has a mean diameter of 1·514 meters, with 282 iron tubes 3·642 meters in length. The total heating surface for a grate surface of 2·38 square meters is 138 square meters.

The high-pressure cylinders have a diameter of 0·33 meter, and the low-pressure ones of 0·558 meter with a piston stroke of 0·66 meter. This engine forms one of a series of three similar locomotives, the weight of which, in running order, is 54·8 tons. The tender is provided with the Ramsbottom water scoop.

Locomotive for One-Meter Track.—Built for the tramway system of La Vendée, this engine, from the Dacauville Works, offers the peculiarity of running normally with the smokestack in the rear, in order to allow the engineman to get a better view of the track. Its weight, in running order, is but 17·3 tons, distributed as follows: 4·6 tons upon the front axle, 6·3 tons upon the intermediate axle, and 6·4 tons upon the hind driving axle. The boiler, which is registered at 15 kilogrammes, has a mean diameter of 0·831 meter, and is provided with 64 steel tubes 0·045 meter in diameter and 1·66 meters in length. Its total heating surface, for a grate surface of 0·65 square meter, is 28 square meters. The diameter of the wheels is 0·84 meter, the stroke of the pistons is 0·36 meter, and the diameter of the cylinders 0·23 meter. The total length of the engine is but 2·2 meters.

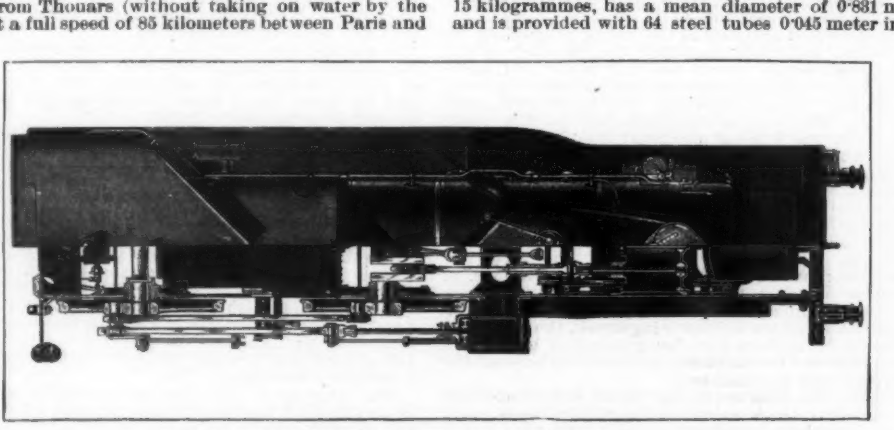


FIG. 2.—PLAN VIEW OF THE LOCOMOTIVE.

Paris-Lyons-Mediterranean Company.—This company exhibits at the Champ-de-Mars and the Vincennes annex, in classes 32 and 33.

At Vincennes there is an electric locomotive, and at the Champ-de-Mars are drawings of the most recent types of steam locomotives. We shall describe only the steam locomotives, which are two in number. These are of the compound type with four cylinders. In 1889, the company already possessed three types of this system, which were then the first that presented the following features: Steel plate boilers registered at 15 kilogrammes, four cylinders acting in pairs upon two different axles, and coupling of the two driving axles.

These characteristic arrangements are found again

to-day in a large number of locomotives of several great French railway systems.

Since 1889 the P.-L.-M. Company has improved its types by the use of the Serve tubes provided with cooling flanges.

High-speed Locomotive, Series C 61.—This engine (Fig. 1) has two coupled axles, one of them straight and the other cranked. The high-pressure cylinders are on the outside of the sole bars (as are also the distributing movements) and actuate the fourth axle. The low-pressure cylinders, which actuate the third axle, are on the inside of the sole bars, as are also their distributing movements. The frame is on the inside of the wheels.

The fire-box, which is of cubical form, is of copper. It consists of a shell in a single piece, of a front plate that receives the fire-tubes, and of a rear or door plate. The tube-plate is connected with the cylindrical body of the boiler by six iron stay bolts, and the vertical faces

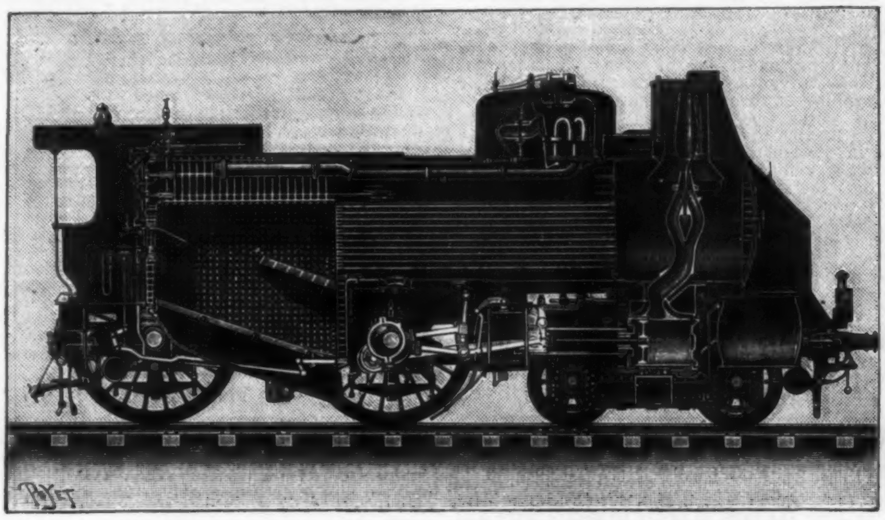


FIG. 3.—LONGITUDINAL SECTION OF THE LOCOMOTIVE.

of the fire-box and furnace are connected by hollow copper stays. The frames of the hearth and door are of iron.

The cylindrical body, which is straight and formed of steel plate, is 3·29 meters in length and 1·44 meter in internal diameter. It rests upon one of the crosspieces of the frame, through the intermedium of angle irons riveted to the boiler.

The fire-box, which is of steel plate and of cubical form, consists of a shell formed of three pieces assembled with two rows of rivets, of a front plate provided with an aperture of which the edges are turned back for the reception of the rear end of the cylindrical body, and of a rear or door plate. The external edges of the front and back plates are turned down so as to lap over the shell of the fire-box, to which they are secured by a double row of rivets. The two opposite lateral plane faces of the shell are stayed above the furnace by means of hollow steel bars.

The plane part in the rear is connected with the cylindrical body by four longitudinal steel stays

FIG. 4.—A LOCOMOTIVE OF THE RAILWAY COMPANY OF THE EAST.

secured to the latter by means of iron cramps, and to the rear stays by straps.

The boiler is provided with 150 fire-tubes of 65 millimeters external diameter, and of a length of 3·4 meters. The water capacity is 3·64 cubic meters, and the steam 2·72, a total of 6·36 cubic meters. The total heating surface is 189·5 square meters, and the grate surface 2·48 for an actual grate length of 2·43 meters and a width of 1·022. The boiler is covered with sheets of brass resting upon a system of supports and held in place by hoops upon the cylindrical body and by screws upon the fire-box. The appendage of the door of the smoke box, the front and rear of the smoke-stack, the front and rear of the steam-dome, and the front of the fire-box are provided with sheets of brass or iron forming a wind-break surface.

The diameter of the driving wheels to the tread is 2 meters. The two high-pressure cylinders are 0·34 meter in diameter. They are situated on the outside of the sole bars, and, as has been stated, actuate the fourth axle. The two low-pressure cylinders, which actuate the third axle, are 0·54 meter in diameter.

The distributing movements of the high-pressure cylinders are of the Walschaert type, and those of the low-pressure cylinders of the Gooch system.

The brake, which is of the Westinghouse type, is automatic and regulatable. The engine is provided with a chronotachymeter of the P.-M.-L. system, with a speed indicator of which the indications may be easily read by the engineman, and with apparatus that permit of heating the trains with steam.

Company of the East.—The locomotive exhibited by the Railway Company of the East at the Vincennes annex was studied with a view to hauling trains of a dead weight of 250 tons upon the line from Paris to Belfort at a mean speed of 90 kilometers.

The profile of this line embraces long gradients of 6 millimeters to the meter and a difference of altitude of 311·48 meters between Paris and Belfort. The engine is provided with a boiler of the Belpaire type, with flanged tubes of the Serve system, and a furnace having a brick arch and two burners for tar (Fig. 4). It is supported in front by a truck and is provided with two pairs of driving wheels 2·05 meters in diameter, the first of which is placed under the cylindrical body of the boiler in front of the fire-box, and the second under the rear part of the furnace.

The frame of the locomotive has sole bars on the inside of the wheels, while that of the truck has exterior ones. Its motive mechanism consists of four compound cylinders. The two high-pressure cylinders, which are placed on the outside of the sole bars, between the driving wheels and the truck, actuate the pair of hind wheels. The two low-pressure cylinders, placed above the truck, on the inside of the sole bars, actuate the pair of wheels placed in front of the firebox. The distributing movement is of the Walschaert type. The brake is of the Westinghouse system, and the steam sandbox of the Gresham & Craven type, with a supplementary movement that allows it to be maneuvered by hand. A registering indicator of speed is placed on the left side in the interior of the cab.

The boiler is of steel, and its furnace of copper. The stay bolts that connect the furnace with its shell, as well as those that connect the two lateral walls of the firebox in the part above the crown sheet of the furnace, are of steel. The firebox is enlarged in the part situated above the wheels so as to receive a furnace of 1·219 meter internal diameter that permits of using 140 Serve tubes of 70 millimeters external diameter. The total heating surface is 207·5 square meters, and the internal capacity of the boiler is 6·722 cubic meters, of which 4·612 is occupied by water and 2·11 by steam. The grate surface is 2·52 square meters.

The locomotive is provided with two tar burners. The object of such an addition is not to replace coal, but, through the supplementary combustion of a certain quantity of tar, to increase the heat developed, and consequently the production of steam. The power of the engine is thus increased on the difficult parts of the road, when, for example, it is a question of climbing the long gradients of 6 millimeters encountered in the trip between Paris and Belfort. The burners are of the Vetillard and Scuerding system. The tar, contained in a reservoir placed upon the tender, is led through a conduit to the base of the ejector, where a cock regulates its outflow. A current of steam then projects it, in dividing it, through the orifice of a tuyere, in which the mixture of steam and tar produces the draught of air necessary for its combustion. The steam may, at a pinch, be directed into a worm placed in the tar reservoir, in order to heat it and give it a proper degree of fluidity. Each of the ejectors permits of burning about 100 kilogrammes of tar per hour.

The truck that supports the locomotive in front is provided with two pairs of wheels 1·06 meter in diameter and spaced 2·1 meters from axis to axis. Its sole bars, which are exterior to the wheels, its two end cross pieces, and its central part are of steel.

The diameter of the two high-pressure cylinders is 0·35 meter, and the stroke of the piston 0·64 meter. The pistons are of the Swedish type with a cast steel body, cast iron segments, and steel rod and counter rod. The distributing valves, which are plane and of the ordinary type, are of bronze. The rubbing parts are lined with anti-friction metal. A manometer located upon the posterior face of the boiler shows the engineman the degree of pressure that exists in the steam chest.

The two low-pressure cylinders are 0·55 meter in diameter and the stroke of the piston is 0·66 meter. The ratio of the volume of the large cylinder to that of the small one is 2·546.

When the engine is running as a compound one, that is to say, when the steam, after working in the small cylinders, is to finish by expanding in the large ones, it is sent directly from the former toward the intermediate reservoir that forms the steam chest common to the large cylinders. In such passage it traverses a box secured to the posterior face of the reservoir, which, in case of a difficulty in starting, or in order to obtain a greater speed, serves for shutting off the entrance of exhaust steam into the reservoir and allowing it to enter the atmosphere directly. This chest communicates on the one hand, through an orifice, with the intermediate reservoir, and, on the other, through a second orifice, with the base of the exhaust pipe of the large cylinders. Each of these two orifices is provided with a clack, and the two clacks are controlled simultaneously, one of them by a cam and the other by a lever keyed upon the same shaft, which the engineman can actuate through a bar connected with a lever placed in proximity to the reversing gear. The arrangement of the cam and lever is such that one of the clacks is closed while the other is open, and reciprocally.

The starting apparatus serves also for running with closed regulator, for running with back steam, and for use in case of damage to the large cylinders, necessitating a momentary run with the high-pressure cylinders solely.

The distributing mechanism is of the Walschaert system. The high and low pressure cylinders have independent distributions.

The brake is of the Westinghouse system. The weight of the locomotive is 58·205 tons, thus distributed: 24·255 tons upon the truck; 16·98 upon the back pair of driving wheels, and 16·97 upon the front pair.

In addition to this locomotive, the Company of the East exhibits a tender of 20 cubic meters capacity as regards water and of 6,000 kilogrammes as regards fuel.—For the above particulars and the engravings, we are indebted to La Nature.

[Continued from SUPPLEMENT, No. 1292, page 20717.]

CHEMICAL AND TECHNICAL EDUCATION IN THE UNITED STATES.*

By Prof. C. F. CHANDLER, Ph.D., M.D., LL.D., D.Sc. Oxon.

MALLETT'S WORK.

A MOST important investigation has recently been published by Prof. J. W. Mallett upon the physiological effect of creatin and creatinin. The main conclusion to be drawn from the investigation is that by far the larger part of the flesh bases, if not absolutely the whole, does not undergo metabolism with the production of urea or anything else; but, on the contrary, is eliminated by way of the kidneys. In the case of creatinin it is excreted unchanged, while creatin is changed wholly or very largely into creatinin.

On the whole, this investigation is unfavorable to the idea of the creatin of living muscle being the main antecedent of urea in nitrogenous metabolism. In the discussion of the results of analyses of meat and forms of food prepared from it, such as soups and the like, it is evidently wrong and misleading to confound together under the head of protein or proteid materials the proteids proper, capable of building up the nitrogenous tissues of the living body, and of furnishing muscular energy and heat by oxidation, and these so-called flesh bases which are taken in along with the food are not valuable for either of these important purposes.

As regards the practical use of meat extracts, those forms of such preparations from which the proteids and peptons have been removed may well be considered as destitute of nutritive value, and those in which, along with some proteid material, the flesh bases occur in large quantity may be considered as deriving no nutritive value from this latter source.

Even if viewed in the light of nerve stimulants only, and thus to be classed with tea and coffee as adjuncts to food, rather than true food itself, meat extracts, so far as the flesh bases, creatin and creatinin, are concerned, are shown by this investigation to be very much less active in their effects upon the nervous system than they have been commonly reported.

OTHER INVESTIGATIONS.

In dairying, the work of the station chemists has

* Read at the nineteenth annual general meeting of the Society in London, in the theater of the Royal Institution, Albemarle Street, on Wednesday, July 18, 1900, Prof. C. F. Chandler, President of the Society, in the chair.

been unusually far-reaching. The elaboration of an accurate and rapid method for testing the fat contained in milk by Babcock, rendering it possible and practicable for intelligent farmers and creamery manufacturers to determine the quality of milk, has resulted in a revolution of the method of purchasing milk at creameries and cheese factories, placing it on the fat basis, and has led to a great improvement in the character of dairy herds by rejecting the poorer cows, and, consequently, an economy in milk and butter production.

A large amount of investigation has been carried on relating to the losses in different processes of butter-making and cheese-making and their reduction. A very important discovery has been made by Babcock & Russell of a ferment in milk which is found to be a normal constituent, and has been demonstrated to be the cause of the proteolytic changes in ripening cheese, in regard to which there had previously been such a confusion of theories.

These agricultural experiment stations are now in operation under the Act of Congress, March 2, 1887, in all the States and Territories. There are 52 in all, chiefly supported by the national government, but also receiving appropriations from the States. Then, and in addition, four, entirely supported by States; and in Louisiana, a station for sugar experiments, maintained partly by funds contributed by sugar planters.

The work of the stations is under the general supervision of the United States Department of Agriculture. Dr. A. C. True is the director of the office of Experiment Stations, and to him I am indebted for much valuable information with regard to them.

CHEMICAL WORK OF THE UNITED STATES GEOLOGICAL SURVEY.

The chemical laboratories of the United States Geological Survey have contributed a large amount of most valuable chemical work, besides a great variety of work in other fields, mineralogy, geology, etc. I am indebted to the director of the Survey, Mr. Charles D. Walcott, for many of the statistics of our industrial resources.

The chemical laboratory of the Survey is under the immediate direction of F. W. Clarke, the chief chemist, who has to deal with all the problems in chemistry which arise in connection with geological research. Naturally, most of the work is analytical, in response to the demands of the geologists, and analyses are made of rocks, minerals, ores, coals, mineral water, etc. The analyses of rocks has been a specialty of the laboratory; over 800 different eruptive rocks alone have been analyzed with a completeness rarely attempted elsewhere. This feature of the work has been particularly developed by Dr. W. F. Hillebrand, whose bulletin upon "Methods of Rock Analysis" is now well known and has become the standard authority upon the subject. His methods for determining small quantities of vanadium and chromium were worked out here, as were also the methods for determining boric acid, titanium, and lithium by Gooch, who was for some years connected with the Survey.

Much mineralogical work has also been done in the laboratory. The minerals zunyite, antlerite and guitermanite were discovered by Hillebrand, hydronephelite by Clarke, warrenite by Eakins, josephinite and powellite by Melville. Rigg's analyses of tourmalinite are well known, and Hillebrand's investigation of uraninite, in which its remarkable gaseous contents were first made known, is classical.

Much of Prof. Clarke's time has been spent upon the study of silicate chemistry, and for fifteen years his papers upon the constitution of the mineral silicates have been numerous. Recently, jointly with Steiger, Clarke has succeeded in replacing the soda potassa or lime of analcite, leucite, natrolite and scolecite by ammonia, opening an entirely new field for chemico-mineralogical research. Ammonium natrolite, containing over 9 per cent. of ammonia, is stable at 300° C., a most unexpected revelation.

Incidentally much other research work has been done; for example, Stokes' investigation of the phosphorous chloro-nitrides was made in this laboratory, and the supposably well-known compound $P_3N_3Cl_6$ was made to develop a series of polymeric compounds, which are so far unique in chemistry.

The work of this laboratory has been so eminently scientific, original and thorough that American chemists hope that its resources may be largely increased in the immediate future, as what has been done is but a small portion of what it may yet accomplish.

SANITARY CHEMISTRY.

In sanitary reforms we have endeavored to follow the practice of England, where sanitary reforms originated. Did time permit, I could give you a very interesting account of the work of the New York Health Department in the seventies in establishing a new standard for sanitary plumbing in dwelling houses and other buildings. It was found at that time there was actually not a properly plumbed house in New York city. After experimenting on the subject and arriving at a conclusion as to what system of plumbing should be adopted, legislation was secured requiring the plumbing and drainage of all buildings thereafter constructed in the city of New York to be in accordance with plans previously approved by the Board of Health, and, in order that there should be no misunderstanding as to what the Board of Health would approve, a plan of plumbing acceptable to the Board was printed and distributed, and ever since that time the rules have been strictly enforced. The example of New York was quickly followed by other cities, until at the present time good sanitary plumbing is found throughout the United States.

The pollution of streams, which received in England so much attention at an early day, did not become an important issue with us until recently, owing to the great size of our rivers and the limited population. Within the last few years, however, the increase in population and the increase in manufacturing establishments has forced this subject upon the public mind, and at present action is being taken in several States to compel cities, towns and villages to purify the sewage before permitting it to be discharged into the streams, and there will be in the near future a demand for chemical and engineering skill to carry out the requirements of legislation in this direction.

For similar reasons the purification of our water supply is now attracting a great deal of attention, and systems of coagulation and filtration have been introduced which greatly simplify the problem. The addition of a fixed but small amount of alum to the water on its way to the filters, together with certain mechanical devices in connection with the filters themselves, has made it possible to filter the water supply of cities of any size with certainty and with great rapidity.

The first large water purification plant in the United States was built at Poughkeepsie, N. Y., in 1872, and the first sewage disposal plant was put in operation at Augusta, Me., in the same year. Since that time the number of works built for the filtration of water has exceeded 175, while the number of plants for the disposal of sewage is probably almost as great.

Of water filters there are at present 20 plants operating upon the English or slow system, supplying an aggregate of 260,000 people, and 154 mechanical filter plants, supplying an aggregate of 1,600,000 people. Water filters are projected or under construction to supply the cities of Louisville, Cincinnati and Pittsburg, with an aggregate of 700,000 inhabitants. A few years ago elaborate experimental investigations were made at the cities named for the purpose of determining the most advantageous manner in which their present supplies of turbid river waters could be purified. The works that have been decided upon are based in principle upon the results of the tests, the progress of construction at Louisville and Cincinnati being already well advanced.

Regarding the sewage disposal plants, there were, in 1897, 143 works for the disposal of sewage in the United States and Canada. The methods employed included chemical precipitation, filtration, broad and sub-surface irrigation and combinations and variations of these principles. Of the total number of plants, 120 were built between 1887 and 1897. Assuming this rate of construction to have continued from 1897 to 1900, it would appear that the aggregate number of inhabitants of cities and towns whose sewage is disposed of by scientific treatment is about 1,000,000 at the present date.

The adulteration of food is attracting more and more attention in the United States, not that adulteration is excessive with us, but from the fact that the public has become extremely sensitive on the subject, and demands pure food. Local health authorities, State Legislatures and Congress are all engaged in the formulation of proper laws and in establishing laboratories for food analyses, in order to secure pure and wholesome food.

CHEMICAL INDUSTRIES IN THE UNITED STATES.

The chemical industries of the United States have made very material progress in recent years.

New industries have been established and old ones developed and enlarged.

While it is not possible in most cases to give exact statistics, much can be learned from the published statements of the production of ores and minerals, and of metals and secondary mineral and chemical products which I present.

In our coal production there has been a large increase within the last year. Over 218,000,000 short tons have been produced, of which 191,500,000 were bituminous coal, 36,000 were cannel coal, and 60,577,000 were anthracite, and there are still most extensive tracts of coal lands which have not been disturbed by the miner's pick.

The coke industry has also increased; 18,000,000 tons were manufactured.

METALS.

The iron industry of the United States now exceeds that of any other country. Over 25,000,000 tons of iron ore were mined in the country, three-fourths of it in the Lake Superior region; ores are also imported to some extent.

The pig iron manufactured amounted to 13,620,703 tons, and the steel to 10,662,170 tons.

The United States has become the largest copper-producing country in the world.

The world's copper product during the year 1899 was 468,463 tons of 2,240 pounds, of which the United States produced 259,517 tons (55 per cent.) Second on the list comes Spain and Portugal with a production of 54,220 tons.

From the native copper deposits of the Lake Superior region 69,574 tons of our copper were extracted. The rest was obtained chiefly from Montana and Arizona from sulphurets.

About two-thirds of the copper produced in the United States was electrolytically refined. American copper-smelting processes have reached a very high degree of efficiency, while they are at the same time comparatively simple. There are 31 copper-smelting establishments in the United States, besides two large establishments devoted primarily to other industries in which copper smelting is carried on, and there are 11 electrolytic copper refineries in the United States. The estimated production of electrolytic copper is 198,600 tons annually, and the precious metals obtained in refining the copper amount to 170,273 ounces of gold and 21,199,200 ounces of silver. It is an interesting fact in this connection that large quantities of tellurium and selenium are obtained as a by-product in refining copper electrolytically, for which, as yet, no use has been found. It is sad to think of tons of tellurium being thrown away because no useful application has been found for this interesting element.

Our zinc mines continue to develop; 129,675 tons of 2,000 pounds of spelter were manufactured during the past year in Kansas, Illinois, Indiana and Missouri chiefly; a little from some other States. Oxide of zinc was manufactured to the extent of 36,663 tons of 2,000 pounds, chiefly in New Jersey, Pennsylvania and Wisconsin. The New Jersey ore is most interesting. It consists of a granular mixture of franklinite and a beautiful green willemite, which is the silicate of zinc, and small quantities of the red oxide of zinc. This ore in mined in large quantities, is coarsely ground and separated by magnetic separators. The franklinite is first used for the manufacture of oxide of zinc, and subsequently for the manufacture of spiegeleisen. The green willemite is shipped to Westphalia for the manufacture of spelter.

The production of lead in the United States fell off a little in 1899, the total amount being 293,508 tons of 2,000 pounds, or 266,269 metric tons.

The gold produced in 1899 amounted to 3,391,196 troy ounces, valued at $70,096,021; the silver to 57,126,834 troy ounces, valued at $34,036,168.

SULPHURIC ACID.

The manufacture of sulphuric acid has grown with great rapidity in the United States, owing to the large quantity of artificial fertilizers and superphosphates which are employed all over the country, North and South. As the phosphates are found in the Southern States, the industry of converting them into superphosphates has been largely concentrated there.

In a very elaborate article on the manufacture of sulphuric acid in the United States, read before the New York Section of our Society in April last year, Mr. Peter S. Gilchrist has described the methods employed, and given valuable statistics. He mentions the fact that at the present time there are 75 fertilizer works where sulphuric acid is manufactured south of Maryland, and he gives the following statement of the quantities of pyrites and sulphur produced and imported:

	1897. Long Tons.	1898 Long Tons.
United States pyrites, 43 per cent. sulphur	128,618	185,298
Imported pyrites, 49 per cent. sulphur	259,546	171,870
Louisiana and Utah sulphur	1,690	2,680
Imported (Sicily) sulphur	138,846	159,790
Estimated amount of 50° B. acid produced (short tons)	1,097,771	1,679,203

The petroleum refineries also consume large quantities of sulphuric acid, as high as 2 per cent. on the volume of oil refined. As this acid does not lose its acidity in the operation, it is either regenerated to be used again or sold to the fertilizer manufacturers for the production of superphosphates.

FERTILIZERS.

Chemical fertilizers constitute one of the most important articles in our chemical industries. Mr. Dodge, of the United States Department of Agriculture, estimates that there are approximately one and a half million tons of fertilizers sold in this country at a cost to the farmers of more than $53,000,000.

The largest consumers of sulphuric acid in this country are the manufacturers of superphosphate of lime, chiefly from the phosphatic rock deposits of Tennessee, South Carolina, Florida, and other States.

Our potash salts and nitrate of soda are all imported, but most of our nitrogen compounds, sulphate of ammonia from the gas works, and animal refuse from our abattoirs and packing houses, such as dried blood, tankage, etc., horns and bones, and cotton-seed meal, are obtained in the country.

Twenty-nine of the States have enacted fertilizer laws requiring that the boxes containing the fertilizers shall have attached to them in some plain manner the name of the manufacturers and the guaranteed percentages of nitrogen, phosphoric acid, and potash soluble in water.

In the State of New York alone there were registered in 1899, 2,268 different brands of artificial fertilizers, the number of manufacturers supplying them being 190.

A most important process has been devised by Joseph Van Ruymbeke for recovering the valuable material which exists in solution in the liquor of the rendering tanks in abattoirs and packing houses. This liquor or soup, as it is called, results from the treatment in the tanks under pressure by steam of all the refuse of the abattoirs and packing houses. The fat is liberated and rises to the top. The meat and bones are cooked, the gelatine and other soluble matters pass into solution in the water of the condensed steam. Many attempts had been made to recover the valuable plant food in this liquor, but on evaporating it to dryness and thoroughly drying it, it was found to be very deliquescent, and it was impossible to handle it successfully. Ruymbeke found that by evaporating this liquor to the consistency of sirup, and adding to it a small percentage of persulphate of iron, it was immediately coagulated and rendered so insoluble that it could be squeezed into a solid mass in the hand without difficulty, and when dried it was found to be entirely permanent. This process is now generally employed, and results in adding a considerable quantity of plant food to the market supply.

In connection with fertilizers and plant food, I must mention the interesting investigations which have been made by Dr. W. H. Birchmore. Dr. Birchmore has made a careful bacteriological study of the curing of stable manure, and has ascertained the conditions under which the desirable microbes can be encouraged, and the proper fermentation secured by which the plant food is retained, and he has also found the conditions under which unfavorable fermentation takes place, and plant food is wasted. The paper on this subject, which he read before the New York Section of this Society, is published in the Journal for February of this year.

SALT.

Salt has long been manufactured in the United States, generally from brines, though valuable deposits of rock-salt occur in Louisiana and New York State. New York State is the largest producer; Michigan follows closely, then come Kansas, Ohio, and West Virginia, California, Utah, etc. The total product for the year 1899 was nearly 3,000,000 tons of 2,000 lb. Improved processes have been introduced, and salt of the best quality is now supplied for dairy use.

SODA ASH.

Soda ash was not manufactured in the United States 20 years ago. Since that time, the Solvay process has been introduced. At the present time there are four establishments working this process. The Solvay Process Company has one plant at Syracuse, New York, and another at Detroit, Michigan, and it is claimed that they turn out at these two plants nearly 1,000 tons daily. The Mathieson Alkali Works, at Saltville, Virginia, turn out 200 tons, and J. B. Ford & Sons at Wyandotte, Michigan, turn out 200 tons.

(To be continued.)

[Continued from SUPPLEMENT, No. 1292, page 20708.]

AMERICAN ENGINEERING COMPETITION.*

XIII.—MALLEABLE CASTINGS, AGRICULTURAL IMPLEMENTS, AND MACHINE-MADE FILES.

THE manufacture of what are known as malleable iron castings is one of the branches of engineering production in which the Americans have been very successful and to which British engineers might, with advantage, give closer attention. For the ordinary mechanic or metallurgist of a past generation to have spoken of a "malleable casting" would have seemed a contradiction in terms. Malleable, or forge, iron was wrought iron—that is, iron smelted from the ore in the blast furnace, cast into pigs, and then treated in the puddling furnace to remove alloy. Such iron is soft, ductile, and has considerable tenacity. It cannot be brought to a fluid state by any means at the command of the engineer, simply becoming "pasty" when highly heated. Cast iron, on the other hand, is readily melted, and is, therefore, easily cast, but is brittle and has low tensility. For complicated shapes the cheaper method of casting, rather than forging, is desirable; but when the part has to withstand blows, as opposed to steady pressure, ordinary cast iron cannot be used with safety.

It has, however, been discovered that iron castings can be made largely to assume the properties of forgings by annealing; that is to say, by subjecting them for a considerable period to a moderate red heat and allowing them to cool very slowly. The process is a most interesting one from a metallurgical point of view. In the most favorable circumstances a malleable casting is almost as ductile as a forging, but, unfortunately, the most favorable circumstances are not always secured. Not only may the results of various batches from the annealing furnace be very variable in quality, but individual pieces from one annealing may show considerable disparity. This want of what is technically known as "reliability" has been the great drawback to the use of malleable castings. Engineers say they dare not put them in positions of trust, and hence the more costly forged and machined parts must be used. In England we have, at any rate, one firm which can show the best proof of success in this direction by having more orders on its books than it can execute. On the other hand, a large number of malleable castings are coming into this country from the United States. That being the case, the subject is one eminently suited to our present inquiry, and I, therefore, considered myself fortunate in being able to visit two or three malleable iron foundries in the United States. American success appeared to be due chiefly to knowledge of the exact composition of the iron and to the proper regulation of temperature in annealing operations.

When malleable castings are used for automatic train couplers, they are put to one of the stiffest tests they are likely to undergo. In American railway practice the coupler and buffer are in one, the coupler itself taking the impact of two cars coming together. It will be easily understood, therefore, that a car coupler must have lost all the brittleness of cast iron and have become exceedingly tough. The Buckeye Malleable Iron and Coupler Company have extensive foundries and workshops at Columbus, the capital of Ohio, where they work night and day on ten-hour shifts, making the Buckeye coupler, producing about six hundred a day of twenty-four hours. The coupler body is a massive iron casting of intricate form that certainly could not be made in one piece by forging, but is comparatively easy to cast. It may be noted here that the malleable cast iron made at these works can be welded; a thing that appears at first altogether extraordinary, but I have since heard that it is not uncommon with American malleable castings and, presumably, British productions also of the same kind. What is even more remarkable is that malleable castings and steel are welded together as an everyday commercial transaction. Such things cause old-fashioned engineers to reconsider the axioms of their youth. The Buckeye Company have the advantage of natural gas for annealing, and they keep a very close check on the heat of their ovens. At their works only charcoal iron is used, but coke-smelted iron is employed by some makers. The absence of sulphur is undoubtedly a desirable feature secured by smelting with charcoal.

Major Goodspeed, the managing director, spent two years and a good deal of money—about £7,000—in experimenting to discover whether annealing could be done without pots or boxes, the pieces being placed in the furnace direct. He has found, among other things, that by packing the parts to be annealed in a special kind of ore, and by paying considerable attention to temperature and cooling, this can be done. I understand these are the only works in which the practice is followed. Some car couplers have been made of steel; but not only is the iron found cheaper, but the annealed castings are more trustworthy. The annealing here is continued for fourteen days, which, I think, is an unusually long time, but the castings are of considerable size. The mechanical principle of the coupling is very ingenious, very simple, and appears most effective in locking two coaches together quite automatically. It may not be generally known in England that on January 1 last it became, by law of the United States, compulsory for all railway stock to be equipped with automatic couplings and brakes; whether it has been possible to enforce the law without paralyzing the carrying trade of the country I am not aware, but, to judge by the state of affairs at the end of last year, I should say, decidedly not. Automatic couplings have a special interest for us just now, as it is proposed to make them compulsory in this country also. Those who are acquainted with American railways will have little doubt that it would be a good thing if the practice could be introduced here. The American engineer has, however, a comparatively easy task, for his trains have always been "central coupled," and "central buffed," while all our rolling stock, as every one knows, has side buffers. A very promising device has, however, been invented by an English engineer, by which the side buffing and central buffing can be combined, or, rather, can be made interchangeable, and, while in Columbus, I saw a number of Buckeye couplers on this principle which were to be sent to England to be fitted on English trains. It may be of interest to add, as illustrating the growth in the weight of trains, that nine years ago, when the Buckeye coupler was first introduced, a pulling strain of little more than half that now demanded was considered sufficient. On March 17, 1899, a train of fifty steel cars was hauled on the Baltimore and Ohio Railroad. The gross weight was 2,888 tons, and each car carried about fifty tons of coal. This is said to have been the heaviest train ever hauled in America, and was fitted with Buckeye couplers.

The Pittsburg Malleable Iron Company own a foundry of the same description, which I was permitted to go through. Here the operations were more variable. My attention was first drawn to this establishment, as to some others I visited, by seeing its product in English workshops. It was at the works of a Sheffield maker of railway appliances that a conversation turned on the dependence to be placed upon malleable iron castings, and by way of illustration I was taken to a large heap of clips made in this way, and was invited to select any number and put them to any test. I tried several, bending and twisting them in a way that would have severely tested wrought iron. At these works I was told that the American castings were not only cheaper, and more to be depended upon than any others, but that orders were more regularly and more quickly executed when the goods came from across the Atlantic. I found at the Pittsburg foundry a good many things being cast for which we should use either steel or iron forgings. The moulding machinery was well arranged and worked by compressed air. The iron is all melted in gas-fired furnaces. Electric motors for street cars and Westinghouse brakes seems to account for a large part of the output. It will give an idea of the magnitude of the work to state that for one engineering establishment alone the firm hold nearly five thousand different patterns. They had recently made a considerable success in turning out rolling mill spindles weighing from 700 pounds to 800 pounds. Spur wheels for motor cars were cast in two halves and bolted together on the shaft. By using these castings a saving in weight of 25 per cent. was obtained over ordinary cast iron, with additional strength and regularity of product. The rims of the wheels are cast in blank, and the teeth to form the gearing are cut out by special milling machines. In this way very close and quiet running gear is produced.

The firm attribute their success chiefly to the use of proper brands of pig iron. They pay a great deal of attention to composition, making analyses continually. It will be remembered that Mr. Archer Brown, of New York, said he made a special iron for malleable castings, and presumably this can be purchased by British foundrymen who desire to follow up a branch of ironfounding that seems to offer a promising field of enterprise. The outlook is more encouraging, as there are several improvements that might be made by which cost of production could be reduced. Possibly the application of the Le Chatelier pyrometer would afford a valuable aid in the annealing operations, as by it the temperature of the furnace could be ascertained at any time. Sir W. Roberts-Austen has given a good deal of attention of late to this beautiful instrument and has most successfully adapted it to practical metallurgical work. At this foundry the men work ten hours night and day, being rated at piece-work wages. As in a good many other American works, they have half an hour for dinner, and prefer it so, as in this way they get off at half-past 5 instead of 6.

In the manufacture of agricultural implements the Americans have always held a prominent position, and many—I do not know whether I ought to say most—of the ingenious devices by which human labor has been supplanted by mechanism in this field have been the characteristic product of American inventive genius. The subject is a big one, but only a few words can be devoted to it here. On my way to Columbus I visited the works of the Warder, Bushnell & Glessner Company at Springfield, Ohio. They make only three kinds of machines, namely, binders, mowers, and reapers, thus carrying out the prominent American characteristic of concentration of effort to the end of doing one thing well. The works are well laid out with special automatic machine tools—extremely interesting to an engineer to see, but, mercifully, quite impossible to describe. One department, however, is not beyond a word picture; it is the painting shop. They do not use brushes, or even the more modern "painting pump." The large floor of the shop is fitted up with a series of tanks having the appearance of small swimming baths. Overhead there are the lines of a suspension railway. The tanks are filled with paint, the articles to be treated are run in on the railway, are lowered automatically into the bath, and are then carried off to drip. In this way a large and complicated agricultural machine can be painted in a few seconds.

This firm has doubled its output during the last four years, and they are extending their export trade in Australia, South Africa, South America, Russia and in Great Britain. The methods of manufacture have been altering of late years, wood as a material fast giving place to iron, the difficulty of getting good timber increasing rapidly. This is interesting, as the encroachments of Americans on our foreign markets in this field used to be attributed to their better supplies of different woods. The management of these works attribute their success chiefly to their better practice in the malleable iron foundry. The McCormick Harvesting Machine Company have enormous works near Chicago. How vast is their establishment may perhaps be best told by saying they produce 1,200 machines every ten hours. They work from 7 o'clock to 12, then take half an hour for dinner, and close at 5.30 P. M. I was informed here that all the English makers combined do not make one-tenth of the number of the machines they produce; and about one-fifth of their output was sent abroad during the previous year (1898). They had received an order from one firm in Paris, Messrs. R. Wallut & Company, for 12,000 machines. I asked a reason why they had been able to do a much larger foreign trade than the British makers, and will give the reply I received, approximately in my own informant's words.

You cannot compete with us in this trade, first, because your system of agriculture is entirely different to ours; it is so much smaller. I have seen a man in England leading a front horse and another man driving the horse in the shafts on a land roller; and nothing else happening. In America one man would be driving a team drawing a seeder and leading another team behind with a drag (or harrow) and another team with a roller behind that; all managed by one man. Besides this the width would be probably 12 feet, instead of six. You have not room for a full sized procession in your little fields.

You have been sitting in that chair ten minutes and during that time we have finished and put into warehouse 20 reaping machines or field mowers, weighing 700 pounds to 1,500 pounds each. You English are our strongest competitors in foreign markets; but the Swedes and Germans were creeping up every day. They copy everything, but copying will never get more than the dregs of a trade. The country that originates will always be ahead. Moreover, it is no good copying patterns unless you copy methods too. If a German buys one of our machines and tries to make it, he is met by difficulties at every turn. He wants our special tools, our organization, our materials; and then he must produce on the same scale we do to get the same economy.

This gentleman also made reference to the use of malleable iron castings, of which the firm probably work up a greater quantity than any other works in the country, the consumption for 1898 being over 18,000 tons. It was subsequently pointed out to me elsewhere that even if there were no difficulty in other respects, it would not be possible to reproduce the American machines in Europe because the practice of annealing iron castings is not sufficiently advanced. The McCormick Company were building a new foundry 1,487 feet long and 88 feet wide, in which they would cast 250 tons of gray iron daily. They have such a well organized system of moulding by special apparatus that only five skilled moulders will be needed for all this immense number of castings. Ordinary moulding, by the old-fashioned hand tools, is one of the most highly-skilled operations in engineering practice; and, perhaps, for that reason the moulder's department is, in some works in this country, the most difficult to manage. The gentleman who gave me the above facts had been with the firm for thirteen years and had seen the business multiplied five-fold in that time, while it has doubled during the last five years.

In the works—which, by the bye, are situated right in Sheffield—to which reference has been made as using American malleable castings I was also shown a number of American files, and when in Philadelphia I made a point of visiting the Black Diamond File Works, whence these tools had come. I was not very sanguine about getting in, as I had had previous experience—not American—of the secrecy with which the manufacture of files is carried on. However, I experienced no difficulty on this occasion, the statement of my desire to inform English engineers how files are made in America at once giving me the attention of the manager of the works in an inspection of the shops, where files are all cut by automatic machines. Now machine-cut files have long been known (and abused) in England; and years after they were in common use abroad it was held that no good work could be done by a file that was not hand cut. We have been living down that prejudice for some time past, but the legend is by no means extinct. Moreover, it is whispered that a good many of the machine-cut files, both home made and imported into this country, used formerly to find their way into the hands of dealers, and occasionally during transit became so mixed that they reappeared as the British hand-cut article. I give no support to this scandal; in fact, having had some experience with machine-cut files of a past era, I can bear testimony that any one accustomed to using a hand-cut file would know if he were given one produced on the earlier machines. No doubt these were defective, but, so far as I could judge, and the manager of the Sheffield works supported this most unreservedly, it would now be impossible to detect the difference between the hand and machine cut files. At the Philadelphia works, which are the property of Messrs. G. & H. Barnett, I found two large buildings full of machines cutting files. The works have a capacity of 3,000 dozen files a day. I was anxious to find out how much was saved by machine cutting, but this Messrs. Barnett could not inform me, as they never thought about cutting files by hand. I regretted this, as it is still said in Sheffield that a practised file-cutter will work as cheaply as a machine and produce a very much better result. However this may be, the American machine-made files are finding their way into Europe and our colonies in ever-increasing numbers, large quantities being sent from the works under notice to Canada and Australia.

It would be utterly impossible to describe the ingenious mechanism by which the work is done. The hand cutter works with wonderful rapidity, and almost instinctively, his delicate sense of touch enabling him after long practice to give just the right blow to raise the tooth. A rigidly held chisel will not effect the latter operation, and this was the stumbling block with the early machines, which earned for machine-cut files an evil character. By a mechanical device which gives an elastic hold on the cutting chisel, and by another arrangement which strikes a blow of the same nature as the hand hammer, the chisel is made to follow in the cut and raise the tooth. The old machine simply punched a hole with a rough edge.

It is satisfactory to know that, though the Americans are sending files across the sea to Sheffield, they are getting a good deal of the steel for making the tools from Sheffield; indeed, the number of places in which I found fine Sheffield tool steel was a very satisfactory feature. A great many of the files are, however, made from "domestic" steel. The manager of these works informed me that they can afford to import steel from England and use a better quality than is adopted for hand-cut files, and yet sell at a lower price, because so much is saved in labor by the use of machinery; although the wages paid are immensely above those that would be received in England by workpeople of a similar class.

* This series of articles on American Industries was written by an expert of The London Times, who made an extensive trip through this country in order to prepare the articles, the first of the series being published in the SUPPLEMENT of July 21.

TRADE NOTES AND RECEIPTS.

To Protect Tools from Rust, carefully heat benzine and add half its weight of white wax, which dissolves completely in this ratio. This solution is applied to the tools by means of a brush. This medium is said to also protect against the action of acidiferous fumes.—Seifensieder Zeitung.

Application of Liquid Carbonic Acid in Painting.—The "al fresco" process formerly so popular in painting consists in working on fresh lime walls, etc., and allowing the decorated lime-plastering to harden gradually in the air. This induration is a simple chemical process. The air always contains a slight amount of carbonic acid, and the lime combines with the same into lime carbonate, which becomes insoluble in water, hence cannot be washed away by rain. But in time the fresco paintings will decay after all, which probably explains why this method has not been made use of for a long time. Oskar Matthiessen, of Copenhagen, has now, by a simple trick, liberated fresco painting from its former drawbacks of easy decomposability and perishableness.

He sprinkles the lime plaster with liquid carbonic acid, so that the insoluble lime carbonate results at once. Thereby the painting is so thoroughly impregnated that it will resist two to three days after its completion all attempts to wash it off, and even any treatment with soap. If it is desired to enhance the durability of the frescoes still further, Matthiessen proposes to smooth them by means of a roller immediately after their completion. This renders the lower ground which is saturated with the colors so dense that neither dust nor water can lodge in the pores of the mural surface, thus preventing decay. The Prussian Minister of Public Worship and Instruction has had thorough experiments conducted with the described process at the Museum of Industrial Art in Berlin, which have been very successful.—Die Umschau.

Choice of Plaster for Good Acoustics.—By Prof. Charles Nussbaum. The author calls attention to the fact that in cases where good acoustics are required immediately on completion of the rooms, the choice of the ceiling and wall plaster is of some importance, especially where a soft timber (tone-color) is desired. Thus, in concert halls, for instance, mixtures of lime and sand or cement, lime and sand are out of place as a plastering, only a mortar of plaster of Paris promising the desired effect. Sand should not be added to the upper layers of this mortar, and a careful smoothing of the surface should not be neglected, so as to avoid all roughness and irregularities.

Plaster of Paris prepared entirely without sand has a favorable action; it is best made of gypsum burnt to white heat. The strongly elastic, delicate surface of this plastering is particularly advantageous for the reflection of the sound waves and for obtaining a soft timbre.

With regard to the transmission of heat and sound such plaster is also of advantage, but the period of drying for it and the masonry underneath must be taken as higher than for plaster of mixtures of lime and sand or lime, cement and sand. The latter disadvantage, however, is offset by the fact that paint or coverings of veneer, fabrics, wall paper, etc., can be applied immediately after the drying, while the alkalies of the lime, and especially those of the cements, may cause injury to such, often very valuable furnishings, as soon as the plaster becomes damp. The latter circumstance may be brought about by the formation of sweat, even where all other causes of dampness are kept off by proper arrangements, while the conversion of the alkalies into carbonates in the interior of rooms takes place exceedingly slowly, because a certain percentage of water, not inconsiderable for cements, is required in the mortar for the process.—Zeitschrift für Architektur- und Ingenieurwesen.

Production of Printer's Ink and Graphite from Acetylene and Carbide.—The heavy acetylene gas C_2H_2 can be decomposed by strong heating or by the electric spark under pressure in such a manner that it dissociates into its components, carbon and hydrogen, and in a like manner an elimination of carbon with formation of water takes place, when acetylene is burned with insufficient quantities of oxygen.

Basing on these observations, it has been proposed before to utilize the finely divided carbon separated in the decomposition of acetylene as a substitute for lamp-black for printer's ink, but this production has so far been found impracticable, since large quantities of heavy tarry hydrocarbon are forming besides the pure carbon, which not only minimize the yield of black, and lower its quality, but also increase the cost of the product, considering the comparatively high price of pure acetylene gas, so that it cannot compete with the lamp-black produced by the other methods.

According to a new patented process by Dr. Adolf Frank, of Charlottenburg, Germany, acetylene or even metallic carbides are resolved by heating with carbonic oxide; in this process the oxygen of the carbonic oxide combines with the hydrogen of the acetylene or with the metal of the carbide, while the carbon of this compound, as well as the carbon contained in the carbonic oxide, separates in the shape of very fine black.

The process takes place according to the following equations:

$$\underset{\text{acetylene}}{C_2H_2} + \underset{\text{carbonic oxide}}{CO} = \underset{\text{water}}{H_2O} + \underset{\text{carbon}}{3C}$$

And for calcium carbide:

$$\underset{\text{calcium carbide}}{CaC_2} + \underset{\text{carbonic oxide}}{CO} = \underset{\text{calcium oxide}}{CaO} + \underset{\text{carbon}}{3C}$$

Or:

$$\underset{\text{calcium carbide}}{CaC_2} + \underset{\text{carbonic oxide}}{3CO} = \underset{\text{calcium carbonate}}{CaCO_3} + \underset{\text{carbon}}{4C}$$

The resulting very light black is separated by elutriation or washing by the usual chemical processes from the caustic lime—calcium oxide—or lime carbonate generated by the decomposition of the carbide. The soot obtained in this manner is exceedingly black and fine, almost equaling India ink in this respect, so that a material is produced which is expected to be suitable for the finest artistic printing.

As regards the technical side of this process, one is not confined to the use of oils and resinous materials for the production of black, but is now enabled to obtain the carbon, heretofore only produced from these organic compounds, from mineral coal and coke, though, it is true, by a detour over carbide.—Neueste Erfindungen und Erfahrungen.

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